

Tests of homemade 200,000 volt capacitors

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This is an "educational toy " Van de Graaff generator from Edmund Scientific that my parents bought for me over 50 years ago. It still runs fine with all the original parts (including the belt). It is advertised as producing 200,000 volts at a few microamperes. It is safe when used as directed in the user manual. Here, however, it is used to test Leyden jars and capacitors. These devices accumulate (store) the output of this machine for 2 to 4 minutes. The accumulated charge can be lethal. Such a setup is *not safe* for use by children or testosterone crazed males trying to impress their girl friends, or by people who have no experience with high voltage techniques. It can also damage nearby voltage sensitive electronic devices like computers, laptops, TV remotes, ipads, and so forth.* Hence, this page is about **test results** and NOT about how to operate the various setups shown here. (* but don't jump to conclusions. I thought I fried a TV remote during one of my experiments. But it turned out someone inadvertently deprogrammed the unit by holding a button down too long. It functioned fine when reprogrammed.)

The second picture shows the placement of a spark gap electrode. It is used to prevent overvoltage on the device being tested.





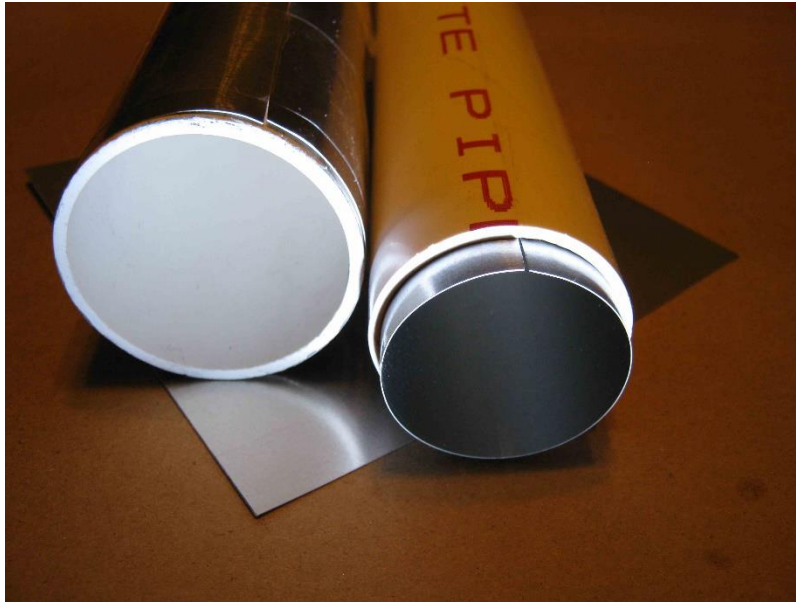
These are two large Leyden jars constructed from a plastic trashcan and a discarded cheese ball jar. Each could only be charged for about 2 minutes. A charge of 4 minutes caused dielectric failure ("punch through") accompanied by a loud firecracker-like explosion. They could stay charged for at least several minutes after the generator was shut off. Note that the foil does not go all the way to the top of the containers. This generous gap is necessary to prevent flashover.



This is a discharge wand with a 2 foot PVC handle. It is made from 1/4" steel rod and two Baoding balls (finger exercise balls) that I got at an oriental food store. I drilled and tapped the balls for the rod. A bolt with two flat washers and two split lock washers (for tension) allows the spherical tips to be adjusted as required. The bolt goes through an eye screw which is epoxied into the handle. During use, one ball is touched to the generator ground and the other is brought near the high voltage terminal. When connected to a Leyden jar, the high voltage terminal discharges with a very loud, thick, bright, long spark.



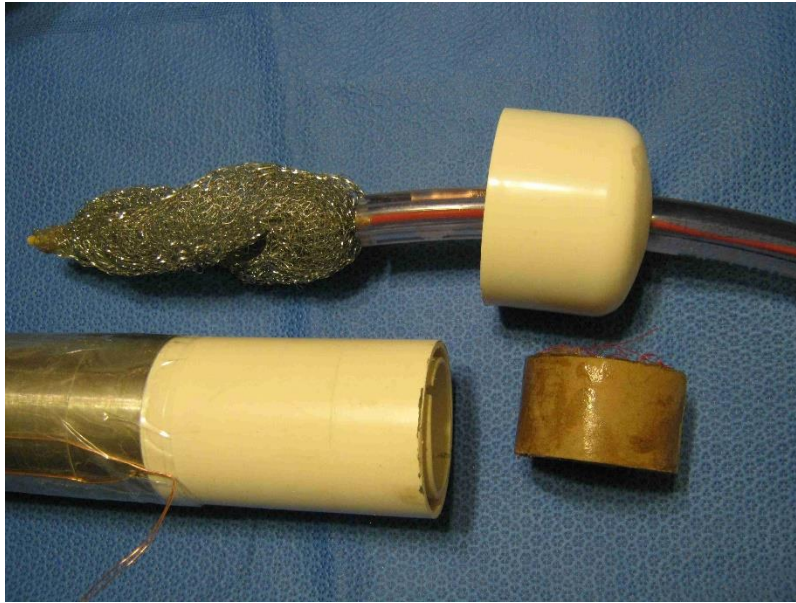
This shows dielectric breakdown ("punch through") at the bottom of the trash can and at the side of cheese ball container. Ordinary aluminum foil was used in the construction. Breakdown punches a neat pinhole in the plastic and blows back the foil. These holes were later plugged with Silicone I sealant, and normal operation was restored.



This shows the placement of foil (aluminum flashing) on a tube-within-a-tube PVC pipe capacitor. Normally a tube capacitor could be constructed with one tube, with foil on the inside and foil on the outside. But this one was intended to use distilled water as the dielectric. The water will go into the annulus formed when the 1.5 inch pipe is placed inside the 2 inch pipe. Note that thin wall PVC pipe was used in this case.



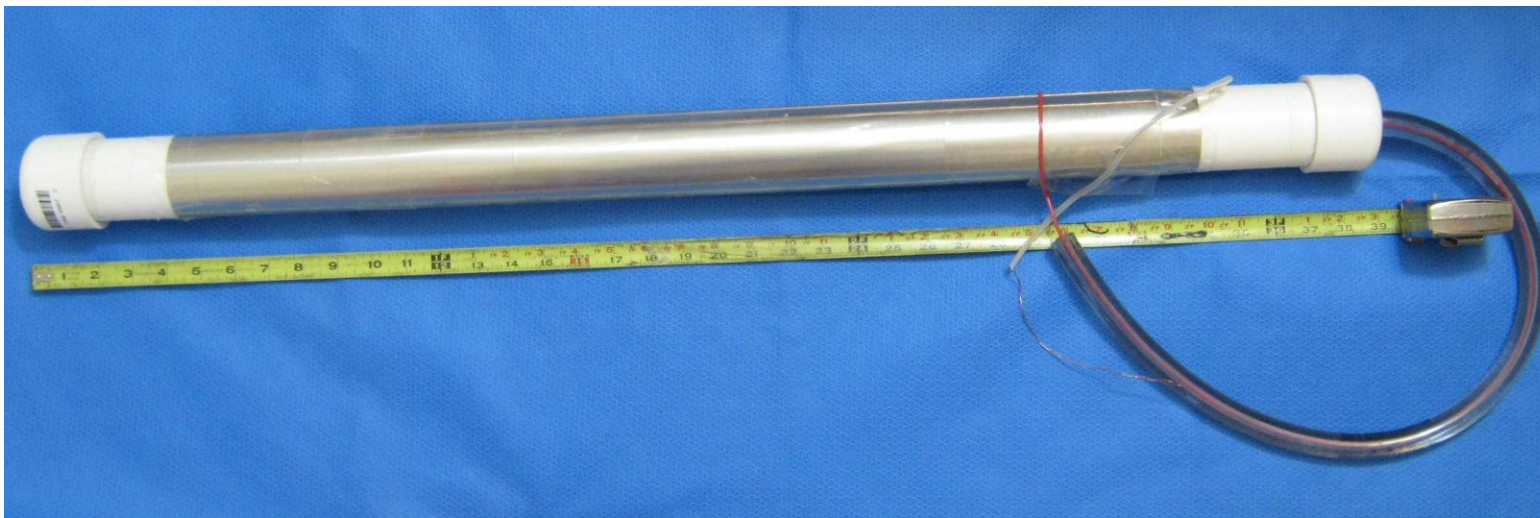
This shows arc-over tracks from surface corona discharge. The aluminum flashing electrodes had to be cut back about 4 inches (both inside and outside) to prevent flashover in air at 200,000 volts. The dielectric stress at the ends of the foil is very high and could be reduced by using Rogowski profiles at foil ends. Lacking that, even corona rings would help. Another alternative is to use semiconductive tapes or coatings containing zinc oxide, silicon carbide, blotting paper treated with copper sulfate, "corona dope", etc. Corona and arc-over eventually destroy capacitors, and also interfere with charging.



High voltage end of the capacitor tube. The outer foil (aluminum flashing) is at ground potential. The inner electrode *connector* is a stainless steel scouring pad epoxied to a bamboo stick and is threaded with #16 AWG wire. It connects with the innermost cylindrical electrode of aluminum flashing. The distilled water goes into the annulus between the two pipes. The epoxy coated paper centering ring is used during dry testing and construction. The thick insulation on the high voltage wire is made from three different diameters of vinyl tubing, the smaller ones being pulled through the larger ones. This capacitor is being dry tested for flashover (at 200,000 volts) and charging time characterization. It can store a dangerous amount of energy even with air/PVC as the dielectric.



This shows the scheme for sealing the inner pipe within the outer pipe and the passthrough for the water fill tubes. The brown rings are made from epoxy coated Kraft wrapping paper. The large ones are cemented to the pipe with expoy (the 6 minute kind) and the narrow ones are movable. The water fill tube is pressed against the capacitor tube with tape and then epoxied. The tape is later removed. The helical wrapping of the water tube keeps the inner dielectric pipe centered within the outer pipe. For final sealing, the inner dielectric pipe assembly is slid into the outer dielectric pipe. The inner pipe is then moved right or left a few inches so that a 1/2" wide layer of Silicone I sealant can be applied first to one end and then to the other. With the ends of both pipes flush, the narrow rings are pushed into the annulus with a suitable tool to compress the sealant and fill any gaps. The water fill tubes are stowed by coiling them in the air gap of the annulus.



This shows the completed capacitor. The outer foil (aluminum flashing) and the two copper drain wires are covered with a couple of layers of packaging tape.

The following test results are typical:

PVC Capacitor tube charging test (dry)	
Tube: 3' x 2" double wall coaxial PVC thin wall water pipe (1.5" + 2")	
Conditions: SG = 43 mm; RH 30%; dry capacitor, horizontal	
Generator: 200,000 volt @ 5 microamp (nominal) Van de Graaff	
Date: July 6, 2001	
Time at Spark Gap firing	Difference (seconds)
25:35	
	42
26:17	
	39
26:56	
	39
27:35	
	39
28:14	
	38
28:52	
	37
29:29	
	36
30:05	

Note that the charging time shortens somewhat as the test proceeds. This is probably because the dielectric tends to polarize over time. A single spark does not fully discharge it. This leaves less dielectric that is actually polarizable, and so the charging times decrease. At the end of the test, the capacitor can carry a residual charge even after being discharged with a wand several times. In fact,

during early testing, I took this capacitor completely apart, handled all the parts and pieces, let them set overnight on the work bench, and when I reassembled it a day later, I got a mild shock. The lesson: *Never trust a "fully discharged" capacitor!* (the "recharge" comes from further relaxation of the polarization of the dielectric as well as from electrons that have diffused into the dielectric itself migrating back out. For the latter,

see <http://205.243.100.155/frames/lichtenbergs.html> For more on the "electret effect"

see <https://sites.google.com/site/appliedbiophysicsresearch/electrets> ; <http://en.wikipedia.org/wiki/Electret>)

The tests for the capacitor in the vertical position gave the same results as those for the horizontal..

Rough measurements using a 28" length of active plate section gave a calculated annular volume of 175 ml. I then injected 90 ml of "distilled" bottled water (grocery store grade). I found unexpectedly that 90 ml was actually the full capacity. I sealed the tubes and proceeded with another charging test:

PVC Capacitor tube charging test (wet)	
Tube: 3' x 2" double wall coaxial PVC thin wall water pipe (1.5" + 2")	
Conditions: SG = 43 mm; RH 30%; wet capacitor, vertical	
Generator: 200,000 volt @ 5 microamp (nominal) Van de Graaff	
Date: July 7, 2001	
Time at Spark Gap firing	Difference (seconds)
34:03	
	49
34:52	
	48
35:40	
	46
36:26	
	45
37:11	
	44
37:55	
	44
38:39	
	44
39:23	
	44
40:07	
	41
40:48	
	44
41:32	
	46
42:18	
	46

The results were both encouraging and disappointing. The charging time increased by 8 seconds, indicating higher capacitance, as expected. But the increase was disappointingly small. Still, this was my first experience with a water capacitor. The fact that it has *any* capacitance after the water was added was encouraging. The device did not leak either, nor flash over, which means that the construction methods are valid, at least for the stated spark gap setting.

In subsequent tests, a Spark Gap setting of 62 mm gave a charging time of 65 seconds, and an SG setting of 70 mm gave about 78 seconds. In the latter case, corona losses at the generator were becoming significant and caused some scatter in the data. A 2.75 inch Spark Gap appears to be roughly the limit of this set up. If the dielectric strength of air is taken as 3 kV/mm, that works out to be about 210 kV. (http://en.wikipedia.org/wiki/Dielectric_strength) A current of 5 microamps for 70 seconds transfers 350 microcoulombs of charge. Energy stored in a capacitor is $U = 1/2 QV$. At 200,000 volts that represents about 35 joules (or enough energy to light a 20 watt fluorescent light bulb for almost 2 seconds). However, that figure is probably high because a Fluke 115 meter shows that the capacitance is less than one nanofarad (which, with $U = 1/2 CV^2$, would be equivalent to 20 joules; additionally this generator's output is probably more realistically 1-2 microamps).

Water, as a liquid dielectric, has the advantage of picosecond relaxation times, which allows for very fast rise times (tens of nanoseconds) in properly constructed high voltage pulse generators (ones that use triggered spark gaps, transmission line techniques, reduction of inductive loop areas, etc.; fast rise times are believed to improve performance in [antigravity generators](#).) Water has a relatively high dielectric constant of about 78.3. A major limitation though is that distilled water tends to be very corrosive. It tries to dissolve just about anything (even air), and becomes somewhat conducting as a result. The residual conductance results in self-discharge, and therefore limits the time available for extracting stored energy after charging. My implementation has no provision for continuous deionization of the water, and this is undoubtedly a limitation. However, the water is in an insulated annulus. But even so, it will still act as a slightly self-discharging capacitor. (For pulsed switching see: <http://event.cwi.nl/icpig05/cd/D/pdf/18-221.pdf> ; <http://www.pulsedpwr.com/PDFs/PPLabsInc-HPMPhaseII-PPPS2009Paper.pdf> ; <http://alexandria.tue.nl/extra2/200712432.pdf>)

Other dielectrics could be used of course. Transformer oil (or an ultradry mineral oil) has a dielectric constant of 2 or 3 and is conventionally used in capacitors, and will work at high voltages. Organic conjugated dienes have dielectric constants in the tens of thousands, but saturate quickly when charged with only a couple of volts

(<http://www.springerlink.com/content/m117200kq47q1n10/> ; <http://www.patentstorm.us/patents/6544651.html> ; http://opus.kobv.de/ubp/volltexte/2011/5119/pdf/stoyanov_diss.pdf). Certain polar organic liquids, with a k in the range of 30-200 can work too. Propylene carbonate, for instance, is especially effective as a capacitor dielectric, as is dimethyl sulfoxide. Use of these (and others) as a dielectric can give energy densities 2 or 3 times that of a water capacitor, but without the problems associated with water. See US [patent 3903460](#) and [3558908](#) for more information. Lead magnesium niobate has a k around 10,000 (<http://physics.info/dielectrics/>), calcium copper titanate, 250,000 (http://en.wikipedia.org/wiki/Relative_permittivity ; [http://www.paper.edu.cn/index.php/default/scholar/downpaper/dangzhimin511435-201001-20\[1\].pdf](http://www.paper.edu.cn/index.php/default/scholar/downpaper/dangzhimin511435-201001-20[1].pdf)). There are even more exotic materials that have "giant dielectric

permittivity" with a k in excess of

a *billion*! (http://repository.upenn.edu/cgi/viewcontent.cgi?article=1158&context=physics_papers) See also [dessicants](#))

In retrospect, I should have tried filling the water capacitor with a mineral oil / barium titanate suspension. This would largely stop the self-discharge. (In May 2012 I dried out the capacitor and injected it with about 90 ml of barium titanate suspension. Testing with a 43 mm spark gap gave a charging time of 68 to 71 seconds, compared with 42 to 36 seconds for the original dry capacitor. Oddly, the charging time seemed to *increase* slightly with time during the testing. Because of the crude experimental conditions, and the fact that 10 months had elapsed since the first tests, I would only conclude that addition of the suspension gave *some* improvement in capacity, and that it was probably better than water in this DC application.)

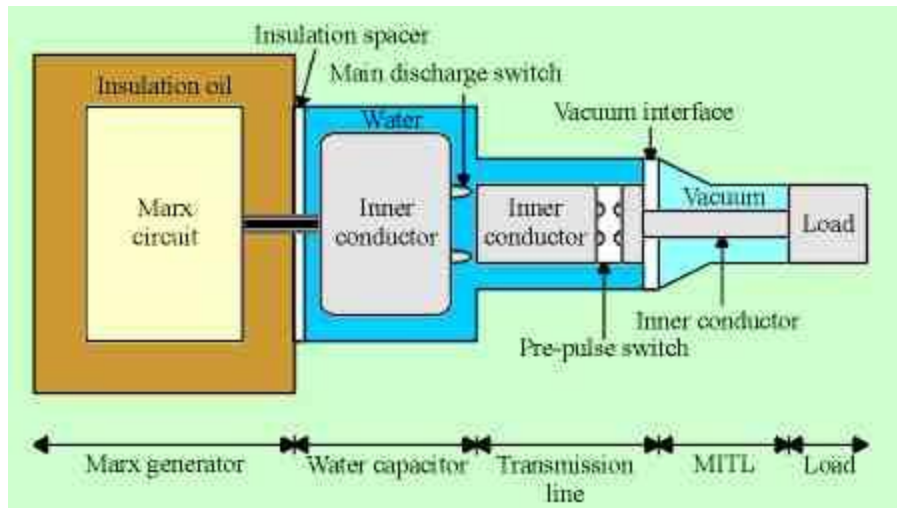
But my thinking here is obviously skewed to DC applications. One of the best ways to use water capacitors is in pulsed power applications:

"Water is a rather important dielectric liquid in pulsed-power applications. It has a relatively high electric breakdown strength (up to 3×10^7 V/m) for submicrosecond electric stress and, owing to its high permittivity, can store quite large energy densities for short times. Most of the electrical characteristics of organic dielectric liquid insulators . . . are also valid for water.

A small fraction (10^{-7}) of water molecules is always dissociated into H^+ and OH^- . These ions lead to a residual conductivity of 4×10^{-6} S/m even for very clean water. Therefore water is inadequate for DC-insulation. . . . Nevertheless, ionic currents do not contribute to the initiation of breakdown for submicrosecond pulses. This has been demonstrated even for salt solutions with concentrations up to 1M. . . . Water, which is largely used in short-pulse applications, has, in addition, the benefit of a high dielectric constant ($\epsilon = 81$), which allows one to store high energy densities.

Under short-duration electric stress, the electric strength of water becomes comparable to that of other liquid insulators. At 1 μs , its strength is around 40MV/m. . . . Its self-discharge time constant is . . . 180 μs . In contact with air, the conductivity increases up to $\sigma = 10^{-4}$ S/m owing to dissolution of CO_2 , leading to . . . 7.3 μs . Therefore energy can be stored only for a rather short time in water-insulated systems, determined by the shorter of the two time constants for breakdown . . . and self-discharge." (*Pulsed Power Systems Principles and Applications*, Hansjoachim Bluhm (2006) p. 38,40; Note: conductivity is given in Siemens per meter)

A water capacitor is best used as an intermediate energy store for pulses in the sub-microsecond range. For example, a single tube version of the PVC capacitor (above) could be built, and five of them connected in a Marx generator configuration. Charging the Marx generator with a toy van de Graaff generator will take several *minutes* but the final output spark could be about a million volts delivered over a [few microseconds](#). As in typical pulsed power configurations, the output could then be fed into a water capacitor which can be charged quickly as an intermediate energy store, and then discharged quickly through another spark gap. The fast relaxation time of the water molecule gives an even faster output pulse (tens of nanoseconds?) which is then fed into pulse forming and impedance matching networks before coupling to the load. Here is a representative illustration from Kumamoto University:



Credit: <http://pps.coe.kumamoto-u.ac.jp/streaming/PulsedPower/generator/content2.htm>

See also: http://www.sandia.gov/pulsedpower/prog_cap/pub_papers/Z_MITLs_120401.pdf

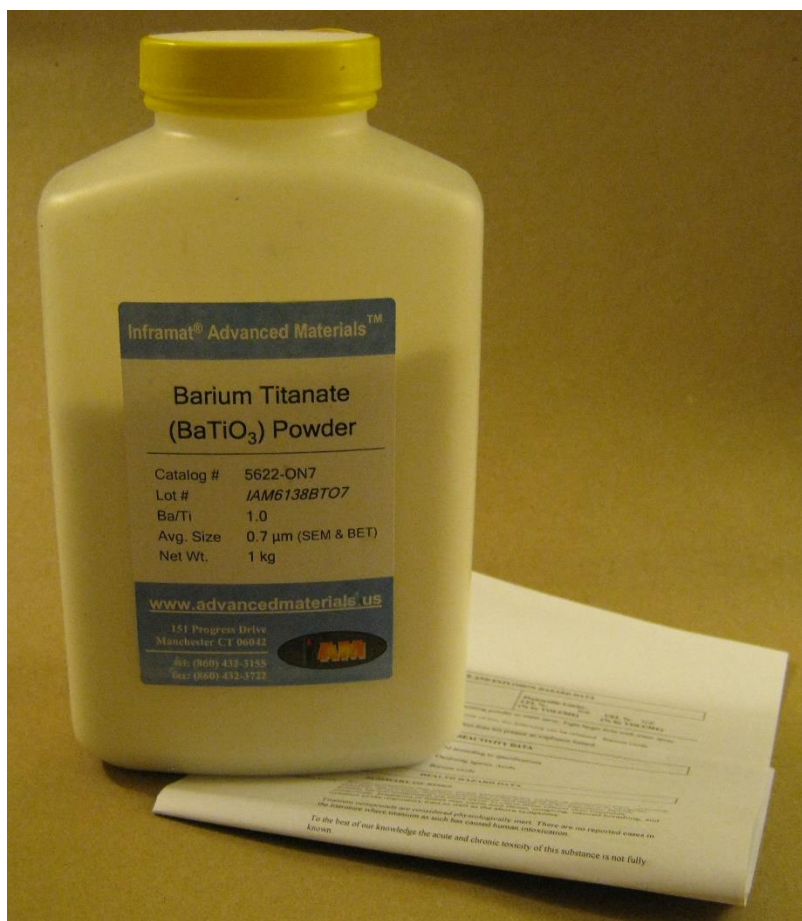
http://www.sandia.gov/pulsedpower/newsreleases/reports/Pulsed_PWR_1st_40yrs.pdf

Other schemes use a peaking capacitor. The Marx generator, with its long chain of spark gaps and simply its overall size, has a fairly high inductance (a few microhenries), which is difficult to reduce because of the extremely high voltage gradients. A properly constructed peaking capacitor, along with another spark gap switch, can reduce this to a few *nanohenries*, which in turn enables rise times of only a few nanoseconds. Some applications, such as flash radiography of exploding materials (as in atomic weapons research), require these high power, ultrashort pulses.

Pulsed power (in the terawatt to exawatt range) has a lot of important applications.

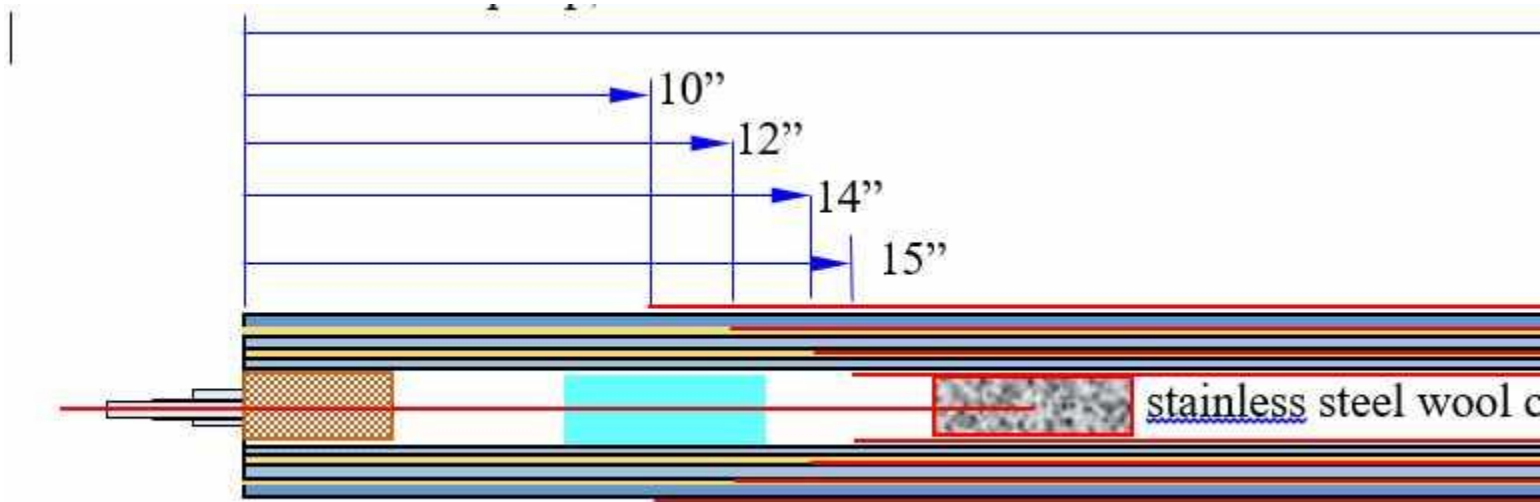
See [Links](#) below. But those are advanced topics. For now, let's continue with simple DC capacitors.

Here is a capacitor I tried to make with barium titanate:



Barium titanate is another common high k material (k of 1250–10,000). I tried making a high voltage capacitor by using it, paraffin wax, computer printer paper, and four copper foil plates. It was a complete failure. I could not even get it to charge. Apparently, there was some sort of internal leakage, but I did not have a gigohm meter ([examples](#)) handy to investigate. At 200,000 volts even a megohm is considered very conducting (do the math). A good insulator would be above 10 teraohms at a minimum. In the photo of the disassembled capacitor shown at right, the two copper plates are separated by a stack of fused waxed paper about 6 mm thick. Notice the extra border needed when tabs are brought out. The resistance could not be measured with a Fluke 115, and so it is greater than 40 megohms (as measured with low voltage).

Years later I decided I wanted a more reliable capacitor and came up with a design that uses three PVC pipes and resistive grading for corona control.:



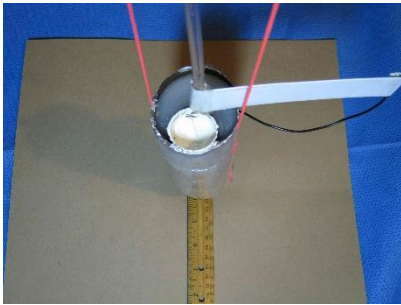
The details are in [proposed 500kV cap.pdf](#)

Brown's lead plate capacitor



http://ralphs-pugh.com/engineering_data/conductivity_of_plastics.html

A stack of lead plates, paper index cards, and paraffin wax was to be used in a test of Brown's [massive cellular gravitator](#). But because of the previous failure with paper and paraffin, the experiment was postponed indefinitely. However, Brown has suggested that a slightly conducting ("semiconducting") dielectric in this kind of application might have an advantage over a perfectly insulating one.



This is a tubular asymmetric capacitor similar to one described in Brown's patents. It is suspended from two pink nylon strings. The inner tube is filled with white barium titanate and bees wax. The outer one is filled with paraffin. The outside is wrapped with aluminum foil and serves as the negative electrode. The wire down the center is in contact, asymmetrically, with the barium titanate/wax mixture. Upon application of a 100,000 volt DC pulse, the assembly is expected to move in the direction of the ruler.

Compare this with Naudin's Poynting Flow Thruster (PFT, <http://jnaudin.free.fr/html/pft01.htm>) His remarks on this are [similar to mine](#) .

Links-General:

http://en.wikipedia.org/wiki/Electrostatic_generator

"The Van de Graaff Generator", Trump, Merrill & Safford (1938). <http://lateralscience.co.uk/VDG/VDG.html> This machine outputs a "half a million volts at around 200uA". (That is sort of equivalent to 100 watts because the 200uA is continuous short circuit amps. If you plan on doing antigravity [replication experiments](#), you will want a VDG in this volt-ampere range. Additional spark gap switches and pulse forming are needed to get the impulse power levels up to a modest 10 million watts (preferably higher) with a repetition rate of 10 pulses

per second (preferably higher). I am trying to design one in this range that should be somewhat easier to build. See [ProjectWhitefire](#))

See also: "The Electrostatic Production of High Voltage for Nuclear Investigations", R. J. Van de Graaff, K. T. Compton, L. C. Van Atta, Rhys. Rev., vol.

43, 149 1933 <http://www.fisicateorica.me/repositorio/howto/artigoshistoricosordemcronologica/1933%20VAN%20DE%20GRAAFF%201933%20Invention%20of%20electrostatic%20accelerators.pdf>

http://mark.rehorst.com/Van_de_Graaff/ (construction experiences)

<http://www.physicsplayground.com/VDG%20Instructions/HOW%20TO%20MAKE%20A%20VDG%202012.pdf> (very good!)

<http://amasci.com/emotor/vdgbg.html> (Van de Graaff Generator Debugging)

http://en.wikipedia.org/wiki/Triboelectric_effect (triboelectric series)

<http://members.tm.net/lapointe/Main.html> ("Bob's High Voltage Home Page")

<http://distributionbizwiz.wordpress.com/2007/09/05/plastic-best-choice-for-high-voltage-capacitors/> (construction tips)

<http://www.plasticcapacitors.com/typelj.html> ; <http://www.plasticcapacitors.com/bulletin1.html> ;

<http://www.plasticcapacitors.com/bulletin2.html>

<http://www.3aassociates.co.in/>

"High Voltage Engineering Practice and Theory", Dr JP Holtzhausen, Dr WL Vosloo, <http://www.dbc.wroc.pl/Content/3458/High+Voltage+Engineering.pdf> (draft)

"The Van de Graaff Generator", Paolo Brenni (1999) <http://lyonel.baum.pagesperso-orange.fr/sis.html>

"A double Van de Graaff Generator", Antonio Carlos M. de Queiroz (1999) <http://www.coe.ufri.br/~acmq/myvdg.html>

<http://cas.web.cern.ch/cas/pruhonice/pdf/dc-accel-DB1.pdf>

http://www.jinaweb.org/outreach/PIXE-PAN09/docs/Accelerator%20Presentation_June2009.pdf

"Arecibo Observatory Transmitter" <http://www.naic.edu/aisr/sas/transmitter/trans-home.html>

"Experiments Which Show That the Earth Functions As an Electrostatic Machine", C. L. Stong, May, 1957

<http://laplace.ucv.cl/Cursos/TrabajoTitulo/ExperimentosBajoCosto/VanDerGraaf/VanDerGraaf02.html>

<http://www.cn-sphere.com/?gclid=CMpvgPStuq0CFasaQgodlAmTAA> (hollow steel spheres, garden gazing balls)

http://unitednuclear.com/index.php?main_page=index&cPath=90 (spheres, Van de Graaff)

<http://www.ikea.com/us/en/catalog/products/50057254/#/00057256> (stainless steel serving bowls; if you visit these stores, be prepared for a very unpleasant navigation experience. They are "Approved Fire Traps")

<http://www.electricstuff.co.uk/> (lots of ideas and stuff)

<http://www.theiapdmagazine.com/pdf/magazine-archives/88.pdf> (tips on cementing acrylic sheet)

Whiskers:

"The most important emission centres are dielectric inclusions, metallic microprotrusions (called whiskers), and adsorbed gases The importance of field enhancement at the emission sites becomes obvious if one calculates the number of electrons per second. . . . To generate 10^6 electrons per second from a flat metallic surface of area 1 cm^2 , an electric field of $1.2 \times 10^7 \text{ V/cm}$ is required. However, for a localised emission site possessing a field enhancement of $\beta = 100$, the same number of electrons is obtained from an area of 10^{-12} cm^2 at a field of only $2.4 \times 10^5 \text{ V/cm}$. (*Pulsed Power Systems Principles and Applications*, Hansjoachim Bluhm (2006) p. 19)

<http://www.eetimes.com/electronics-news/4234309/Toyota-accelerations-revisited-hanging-by-a-tin--whisker> ; <http://nepp.nasa.gov/whisker/background/index.htm>
<http://www.intel.com/technology/itj/2008/v12i1/1-materials/4-second-level.htm>
<http://www.dataclean.com/pdf/zincwhiskers3.pdf>
<http://uk.reuters.com/article/2013/02/12/uk-boeing-dreamliner-battery-dendrites-idUKBRE91B08220130212>

http://scripturalphysics.org/qm/adven.html#ChargingWith_AC/DC_waveform (how to prevent whiskers in batteries)

(When making breakdown measurements on electrodes, especially ones that may contain tin, zinc, brass, or bronze, it is wise to do a few conditioning runs to eliminate the effects of whiskers, which can grow during storage.)

Capacitors:

http://wiki.4hv.org/index.php/Rolled_foil_capacitor_-_60_kV,_3.5_nF

<http://www.mirrorsheeting.com/> (a possible source of clear or aluminum coated mylar sheet)
<http://www.usplastic.com/catalog/item.aspx?itemid=24477&catid=748> (clear mylar sheet)

Links_Electrostatic Generator Patents

"High Voltage Electrostatic Generator Machine", Noel Felici
(1954) <http://www.freepatentsonline.com/2675516.pdf>
<http://www.freepatentsonline.com/2523689.pdf>

US 2702869

US 2656502

US 3400282

Links-DC Tesla Coils

<http://www.scribd.com/doc/15125148/Secrets-of-Cold-War-Technology> (*Secrets of Cold War Technology*, Gerry Vassilatos)

Tesla Transformers are not magnetoelectric devices, they use radiant shockwaves, and produce pure voltage without current. No university High Frequency Coil must ever be called a "Tesla Coil", since the devices usually employed in demonstration halls are the direct result of apparatus perfected by Sir Oliver Lodge and not by Nikola Tesla. The Tesla Transformer is an impulse apparatus, and cannot be as easily constructed except by strict conformity with parameters which Tesla enunciated. Tesla Transformers produce extraordinary white impulse discharges of extreme length and pressure, which exceed the alternating violet spark displays of Lodge Coils. This is illustrated by noting the manner in which Tesla Transformers are actually constructed. While looking and seeming the same, each system actually performs very different functions. Lodge Coils are alternators. Tesla Transformers are unidirectional impulses.

p. 37)

The "Tesla Transformer" primary circuit was comprised of a high voltage (e.g., 15,000 volt) Direct Current generator which charged a high voltage capacitor. When the capacitor charge was sufficiently high, it was discharged suddenly by a spark gap which fed the current into a copper bus bar. Such a discharge would normally produce "electrical ringing" (alternating currents) in the capacitor discharge circuit. The Tesla Transformer scheme specifically suppressed these oscillations by using a powerful magnetically quenched spark gap (the later designs were also immersed in mineral oil, and some were bimetallic (copper/carbon; p.47, 48) which improved the unidirectional characteristic). The scheme produced a monopolar (unidirectional) pulse, with fast waveform rise and fall times. The pulses could be repeated thousands of times per second depending on the spark gap setting and other circuit parameters. Several strange and inexplicable effects were noted during the operation of this type of "transformer", including the "whitefire effect", which incidentally, also resembles the brilliant white glow reported in certain UFO sightings. Additionally:

Tesla was amazed by the fact that mass ratios governed the efficient operation of his æther Transformers. The wonderful fact that mass ratios provided the most efficient transaction of broadcast energy was the mystifying reminder that these energies were not electrical. No electrical law existed in just such a bizarre format, not even when describing inductions between high frequency alternators. The original gas-dynamic implication inherent in this strange ratio

(p. 45, cf. 51)

The ætheric carriers contained momentum. Their extreme velocity matched their nearly massless nature, the product of both becoming a sizable quantity. They moved with superluminal velocity, a result of their incompressible and massless nature. Whenever a directed radiant matter impulse begins from some point in space, an incompressible movement occurs instantly through space to all points along that path. Such movement occurs as a solid ray, an action defying modern considerations of signal retardations in space. Incompressible raylines can move through any distance instantly. Should the path be 300,001 kilometers long, the impulse at the source end will reach that point as quickly as at all other points. This is superluminal velocity. Radiant matter behaved incompressibly. In effect, this stream of radiant matter, virtually massless and

(p. 52)

Lost Science, Gerry Vassilatos, p. 87+

(http://www.tuks.nl/pdf/Reference_Material/Aetherforce_Library/Lost%20Science/Gerry%20Vassilatos%20-Lost-Science-Complete-Edition.pdf)

The Free Energy Secrets of Cold Electricity , Peter A. Lindemann, D.Sc
, http://www.teslasociety.ch/info/NTV_2011/free.pdf

<http://www.freepatentsonline.com/0685957.pdf> , <http://www.freepatentsonline.com/0685958.pdf> , (describes apparatus for receiving and utilizing radiant energy)

https://ia700403.us.archive.org/19/items/CompletePatentsOfNikolaTesla/Complete_Patents_Nikola_Tesla.pdf

<http://www.richieburnett.co.uk/dcresist.html>

[Biconical Fast Spark gaps.](#)

"Victorian Tesla Coil, with reference to a possible medieval coil" <http://lateralscience.blogspot.co.uk/2012/07/victorian-tesla-coil-with-reference-to.html>

["Beyond Einstein: non-local physics"](#), Brian Fraser (2015)

[UFO Physics](#) (note the comments on Weyl fermions, neutrinos, and magnetic spark gaps. Tesla believed that there are two different kinds of electric currents, and that they could be magnetically separated.)

Links-Marx Generators:

<http://www.teravolt.org/marxgen.php>

<http://hackaday.com/2010/10/23/marx-generator-knocks-our-rocks->

[off/](http://www.lucidscience.com/off/) ; <http://www.lucidscience.com/off/> ; <http://home.earthlink.net/~jimlux/hv/marx.htm>
http://en.wikipedia.org/wiki/Marx_generator
"Ultra -Compact Marx-Type High Voltage Generator", <http://www.freepatentsonline.com/6060791.pdf>
http://accelconf.web.cern.ch/accelconf/p69/PDF/PAC1969_0064.PDF

SIBNIIIE the 7 Megavolt Marx Generator:

<http://www.youtube.com/watch?v=vPPMaDH7L7I>
<http://ru-abandoned.livejournal.com/977217.html>
[http://www.thelivingmoon.com/47john_lear/02files/Strange Towers in a Russian Forest.html](http://www.thelivingmoon.com/47john_lear/02files/Strange_Towers_in_a_Russian_Forest.html)
<http://www.abovetopsecret.com/forum/thread319602/pg1>

<http://www.appliedpulsedpower.com/wp-content/uploads/2008/11/pmc2006-solid-state-marx-generator.pdf>
<http://www.appliedpulsedpower.com/wp-content/uploads/2008/11/pmc2006-solid-state-spark-gap-replacement.pdf>
<http://www.appliedpulsedpower.com/wp-content/uploads/2008/11/pmc2008-marx.pdf>

Links-Corona/Dielectric stress reduction:

"Effects of Corona Ring Design on Electric Field Intensity and Potential Distribution Along an Insulator String", Suat Ilhan, Aydogan Özdemir, http://www.emo.org.tr/ekler/43098afe85a1d30_ek.pdf

"An Overview of Lapp Insulator High Voltage Bushing Design", W. A. Young, <http://www.linemangrade.com/literature/bushings/PCO-overview-electric-hv-bushing-design.pdf>

"Optimal Electrical Design of Condenser Graded High Voltage AC Bushings", Mohammad Reza Hesamzadeh, Nasser Hossein-zadeh, <http://itee.uq.edu.au/~aupec/aupec06/htdocs/content/pdf/144.pdf>

[http://en.wikipedia.org/wiki/Bushing_\(electrical\)](http://en.wikipedia.org/wiki/Bushing_(electrical))
; http://en.wikipedia.org/wiki/High_voltage_cable
http://www.elect.mrt.ac.lk/HV_Chap5.pdf (sections 5.3.2 and 5.3.3)
<http://www.electrotechnik.net/2011/11/capacitance-grading.html> ; <http://www.electrotechnik.net/2011/11/intersheath-grading.html>

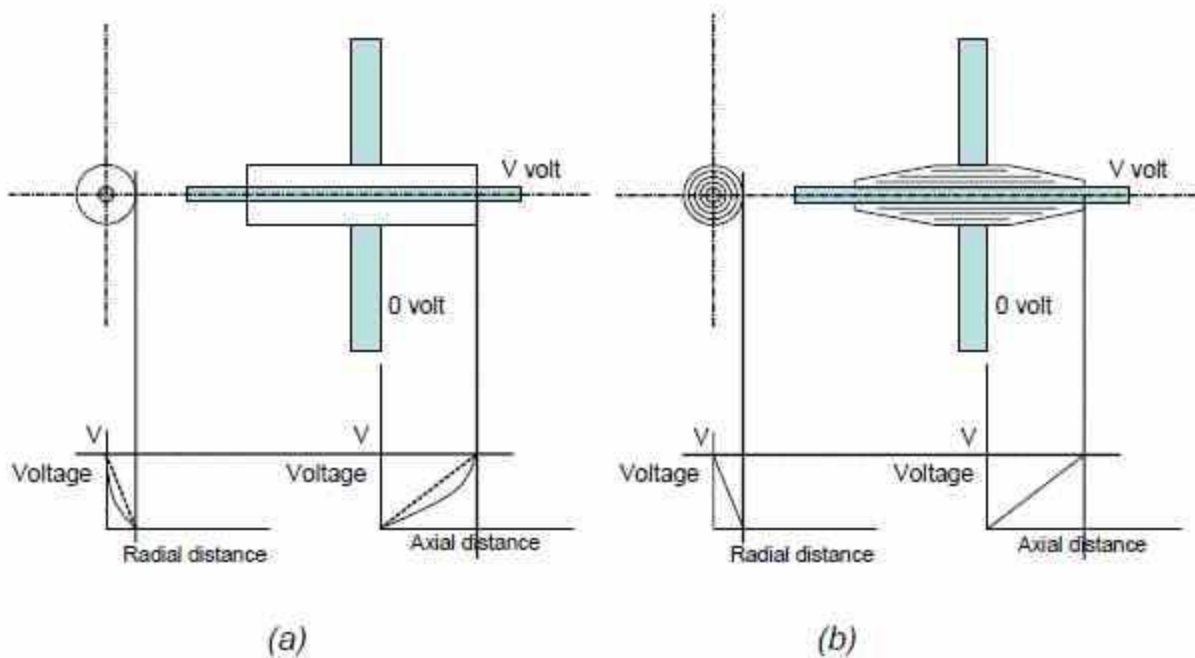


Fig. 1.14: Normal straight through epoxy resin bushing and (b) capacitively graded paper and oil bushing.

High High Voltage Engineering Practice and Theory, Dr JP Holtzhausen, Dr WL Vosloo (draft version) http://www.dbc.wroc.pl/Content/3458/high_voltage_engineering.pdf

"Electrostatic Grading Structures", J.C. Martin, (1970) <http://www.ece.unm.edu/summa/notes/HVN/HVN%201.pdf>

Rogowski, Bruce, Harrison and Borda electrode profiles:

<http://home.earthlink.net/~jimlux/hv/rogowski.htm>
<http://home.earthlink.net/~jimlux/hv/bruce.htm>
<http://books.google.com/books?id=u71WSDOkzxIC...>
<http://books.google.com/books?id=MXqEI-he0EC...>

Links: Electroscopes

Coulomb's torsion

balance, <http://www.magnet.fsu.edu/education/tutorials/java/torsionbalance/index.html>

Links: Pulsed antigravity

Thomas Townsend Brown

"Electric Flying Machines: Thomas Townsend Brown", Gerry

Vassilatos, <http://borderlandresearch.com/book/lost-science/electric-flying-machines-thomas-townsend-brown/1> (This interesting article is split-up into 25 pages on the web. Note the references to repetitively pulsed high voltage power (often omitted in descriptions of these experiments). This is

important. The mysterious "black band" or "dark streamer" effect is also described. Further, the strange "dematerialization" effect referred to, might actually be a "delocalization" effect. Perhaps the distinction will prove to be moot, but "dematerialization" means that the object and its constituent matter are destroyed; "delocalization", on the other hand, does not actually destroy the object, but means its constituents become "non-local" or "non-contiguous" in the reference system. It might be possible to reconstitute such an object. (cf.

[In Search of the Geometry of Space, Time and Motion](#)) This informative article again leaves me with the impression that antigravity effects should be easy to demonstrate.

) <http://customers.hbc.com/~wenonah/history/brown.htm> ; <http://www.newphysics.se/archives/keelynet/gravity/aero2.txt> ; [Biefeld-Brown effect](#);

George Samuel Piggott

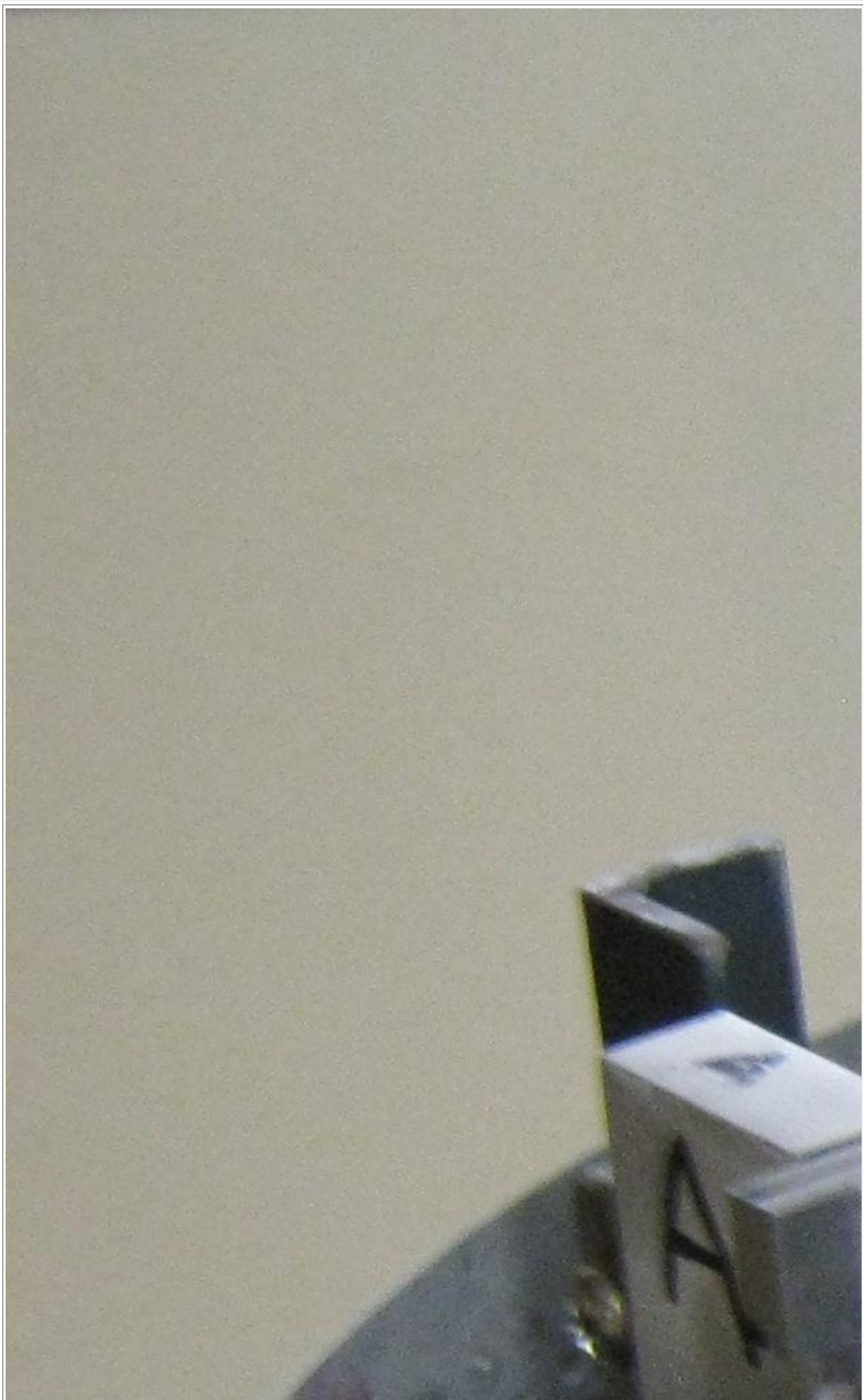
See [summary](#)

<http://www.rexresearch.com/piggott/piggott.htm> (includes a "dark belt" observation)

<http://www.freepatentsonline.com/1006786.pdf> (1911, Piggott's static generator for a space telegraph)

<http://borderlandresearch.com/book/lost-science/electric-flying-machines-thomas-townsend-brown/9>

<http://www.ttbrown.com/forum/viewtopic.php?f=10&t=12&start=90&st=0&sk=t&sd=a>



Spheres for testing the Piggott arrangement can be assembled from stainless steel serving bowls (Ikea 5", 11" and 14" shown)

See <http://www.ikea.com/us/en/catalog/products/50057254/#/00057256>

Upper roller assembly mounted inside 14" bowl.

([inside_upper_terminal_IMG_0955.JPG](#)) See:

<http://scripturalphysics.org/4v4a/ProjectWhitefire/ProjectWhitefire.html>

Loosely related: "Why Such Uproar Over Ultrawideband?", John McCorkle (2002) http://www.eetimes.com/document.asp?doc_id=1277563

Edward S. Farrow

<http://www.rexresearch.com/farrow/farrow.htm> (weight reduction by means of a "condensing dynamo")

http://www.auctiva.com/hostedimages/showimage.aspx?gid=780399&ppid=1122&image=470211125&image_s=470211109,470211125,470211142,470211088&formats=0,0,0,0&format=0 (4 pictures of Technical World Magazine, Vol XVI,

No.3, November 11, pages 257-260. Note reference to "condensing dynamo" and "current sent the wheels in the dynamo whirring".

The complete article is not shown. A patent was not issued. The description is too vague to reproduce the device (possibly, it included the equivalent of an ignition coil, a rotary spark gap, and aerial wires). The references to "spiritism" and "psychic powers" are disturbing, but their applicability to Farrow and his experiments is not clear in this partial article (4 of 7 pages). Such things are disturbing to Christians (and "scriptural physicists") because Satan is an expert at "empty deception" (Colosians 2:8). Satan can make an effect appear to exist and be true, when in fact there is nothing there at all, not even a clever trick.)

[http://query.nytimes.com/mem/archive-](http://query.nytimes.com/mem/archive-free/pdf?res=F40C12FF3A5517738DDDAF0994DF405B818DF1D3)

[free/pdf?res=F40C12FF3A5517738DDDAF0994DF405B818DF1D3](http://query.nytimes.com/mem/archive-free/pdf?res=F40C12FF3A5517738DDDAF0994DF405B818DF1D3)

<http://books.google.com/books?id=eLIMAAAYAAJ&pg=PA260&lpg=PA260&dq=edward+farrow+condensing+dynamo&source=bl&ots=2LhmIyuQsz&sig=Kvw4Zbrp8epEZa6SjVRWrkoMgzo&hl=en&sa=X&ei=rat0UKvgEYKsjAK3i4GACw&ved=0CDAQ6AEwAw#v=onepage&q=edward%20farrow%20condensing%20dynamo&f=false>

"Science versus Gravity" (1911) <http://www.flightglobal.com/pdfarchive/view/1911/1911%20-%201046.html>

Eugene Podkletnov

<http://www.americanantigravity.com/interviews/eugene-podkletnov-on-the-gravity-impulse-generator.html#more-956>

<http://www.youtube.com/watch?v=AgyAFElQZcU&feature=related> (Podkletnov interview)

<http://jnaudin.free.fr/lifters/files/ElectrograviticsElectrokineticsValone.pdf>

<http://xxx.lanl.gov/abs/physics/0108005>

[3-30-11 Update](#)

Charles R. Morton effect

[Morton effect](#) "Van de Graaff Generator Effect", Charles R. Morton

<http://amasci.com/freenrg/morton1.html> , <http://amasci.com/freenrg/mort2.txt> http://groups.google.com/group/sci.physics.relativity/browse_frm/thread/25991020eef22a11...

Francis Nipher

Ducretet

Other

Advanced Electromagnetism and Vacuum Physics (World Scientific Series in Contemporary Chemical Physics, 21) , Patrick Cornille (2003) "This book is aimed at a large audience: scientists, engineers, professors and students wise enough to keep a critical stance whenever confronted with the chilling dogmas of contemporary physics." --Publisher (looks interesting, haven't read it, might be relevant but appears to be of doubtful usefulness)

"United States gravity control propulsion research", http://en.wikipedia.org/wiki/United_States_gravity_control_propulsion_initiative

"Conquest of Gravity Aim of Top Scientists in U.S.", New York Herald-Tribune, Sunday, November 20, 1955, http://www.bibliotecapleyades.net/ciencia/secret_projects/project048.htm .

Links: Pulsed Power:

Interest in machines that can produce short pulses of millions of volts at 100,000 amps for tens of nanoseconds has grown considerably in the last few years. The related design literature is very specialized, hard to find, and expensive. Some of the following references could be helpful. However, I suggest reviewing the various (free) .pdf files first, especially those from Kumamoto University (Japan) and Scandinavia and Germany. Additionally, some of the books occasionally become available used, still in good condition and at considerable discounts. Interlibrary Loan services at your local library, even in small towns, can also be helpful for getting a copy into your hands.

Perhaps even better is electronic access thru a local library account which will often have EBSCO Host or some sort of academic search facility listed under a "General Research" category. Often you can use these by logging in online, but a few require you to actually be at the library. Most of these articles are very technical, or specialized, and beyond the scope of this presentation. Only a few have been included below.

http://en.wikipedia.org/wiki/Pulsed_power

http://en.wikipedia.org/wiki/Pulse_forming_network

"Digest of Technical Papers", Tenth IEEE International Pulsed Power

Conference, <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=599704> (Table of Contents only)

<http://www.lboro.ac.uk/departments/eese/research/energy/pulsed-power/projects/tesla-based-high-voltage-generators-tab-content.html>

J.C. Martin on Pulsed Power, John Christopher Martin, Thomas H. Martin, Arthur Henry Guenther, Magne Kristiansen (1996). See a sample

at: http://books.google.com/books?id=9ORb4YQ6r1YC&printsec=frontcover&output=reader&retailer_id=powells_prod Martin's book takes an historical and practical approach to explaining the design of pulsed power equipment:

"The final chapter is Chapter 12, **High Voltage Design Considerations**. This chapter contains information on constructing pulsed power devices. The chapter shows how to build simple and inexpensive high voltage systems using readily available materials." (preface xv)

"The aim of this short series of experiments was to show the feasibility of a generator providing a current of about 300 kA with a maximum rate of rise of about 8×10^{13} amps per second, by means of a cheap, simple system. " (p. 439)

"There are voltage grading rings at either end of the Marx columnThe form . . . is race-track in plan and toroidal in cross-section. . . . The complex shapes can be quickly and cheaply made from polyurethane foam . . . which is then covered with . . . aluminum foil which is twin stuck onto the polyurethane foam. . . . the two complex bungs for the Marx were made in less than a day by one person." (p. 504)

"The production of a 1 MV pulse charged adjustable capacitor of several hundred nanofarads, whose inductance must be only ten nanohenries or so, would seem to those not versed in modern high voltage techniques to be a major undertaking. It is pleasant to record that it took 3 people only 1 day to make it." (p. 511)

Pulsed Power Systems: Principles and Applications, Hansjoachim Bluhm (2006) For a sample see: <http://www.springerlink.com/content/978-3-540-26137-7/#section=457308&page=1&locus=49> ("This is an excellent book on this topic."-BF)

Transient Electronics: Pulsed Circuit Technology, Paul W. Smith (2002)

Pulsed Power, Gennady A. Mesyats (2004)

High Voltage Engineering Fundamentals, Second Edition (Newnes) [Paperback] John Kuffel, E. Kuffel, W. S. Zaengl (2000)

Pulse Power Formulary, Richard J. Adler, (1991) http://www.isi.edu/~vernier/pp_formulary.pdf

Pulsed Power Engineering, 2011, Prof. Sunao Katsuki lecture series:

"Introduction", http://www.eecs.kumamoto-u.ac.jp/~katsuki/lectures/pp_eng/no1.pdf

"EMF Theory", http://www.eecs.kumamoto-u.ac.jp/~katsuki/lectures/pp_eng/no2.pdf

"Basic Pulsed Power Circuits and Energy Storage Systems", http://www.eecs.kumamoto-u.ac.jp/~katsuki/lectures/pp_eng/no3.pdf

"Transmission lines" http://www.eecs.kumamoto-u.ac.jp/~katsuki/lectures/pp_eng/no4.pdf

"Gaseous Breakdown", http://www.eecs.kumamoto-u.ac.jp/~katsuki/lectures/pp_eng/no6.pdf

"Pulsed Power Components", http://www.eecs.kumamoto-u.ac.jp/~katsuki/lectures/pp_eng/no8.pdf

"Gaseous Switches", http://www.eecs.kumamoto-u.ac.jp/~katsuki/lectures/pp_eng/no9.pdf

"Solid State Switches", http://www.eecs.kumamoto-u.ac.jp/~katsuki/lectures/pp_eng/no10.pdf

"Voltage Multiplication", http://www.eecs.kumamoto-u.ac.jp/~katsuki/lectures/pp_eng/no11.pdf

"Pulse forming and pulse compression", http://www.eecs.kumamoto-u.ac.jp/~katsuki/lectures/pp_eng/no12.pdf

"Pulsed Power Systems", http://www.eecs.kumamoto-u.ac.jp/~katsuki/lectures/pp_eng/no13.pdf

"Voltage and Current Measurements", http://www.eecs.kumamoto-u.ac.jp/~katsuki/lectures/pp_eng/no14.pdf

u.ac.jp/~katsuki/lectures/pp_eng/no14.pdf

"Pulsed power generator system", <http://pps.coe.kumamoto-u.ac.jp/streaming/PulsedPower/PulsedPower.htm> This appears to be a site under construction. Lots of good info. Other samples:

<http://pps.coe.kumamoto-u.ac.jp/streaming/PulsedPower/RAM/bluhm/pplesson1.ram>

<http://pps.coe.kumamoto-u.ac.jp/streaming/PulsedPower/RAM/bluhm/pplesson2.ram>

<http://pps.coe.kumamoto-u.ac.jp/streaming/PulsedPower/RAM/bluhm/pplesson3.ram>

Pulsed Power Technology and Applications-Scandinavia, K. Ahlfont, H. Sandborgh (1999)

http://www.energy.ca.gov/process/pubs/pulsed_power_tech_tr112566.pdf (Scandinavia)

"Commercial Pulsed Power Applications in Germany", Markus J. Loeffler, <http://hochleistungspulstechnik.fh-gelsenkirchen.de/uploads/media/Paper-PPT-02-37-PST-02-80.pdf> (Germany)

"Pulsed Power Research and Technology at Sandia National Laboratories", <http://www.osti.gov/bridge/servlets/purl/584935-NoA57G/webviewable/584935.pdf> (USA)

"Frank Reidy Research Center for Bioelectrics", <http://www.odu.edu/engr/bioelectrics/index.html>

Principles of Charged Particle Acceleration, Stanley Humphries, Jr. (1999) "I highly recommend reading chapters 9 and 10 of this publication."-BF

http://www.lpl.arizona.edu/~guofan/literature/othersort/monograph/principles_of_charged_particle_acceleration.pdf

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<http://www.freepatentsonline.com/5399910.html>

<http://www.freepatentsonline.com/5274271.html>

<http://www.freepatentsonline.com/6633093.html>

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Crushing", <http://205.243.100.155/frames/shrinkergallery.html> ; <http://205.243.100.155/frames/shrinker.html>

"A Bibliography of the Electrically Exploded Conductor Phenomenon," by William G. Chace and Eleanor M. Watson, published by the Armed Services Technical Information Agency. http://www.dtic.mil/cgi-bin/GetTRDoc?AD=AD0299253&ei=-awUrSVOJDyoASBhoD4Aw&usg=AFQjCNEFD9cm912JxlQITL8tr1BosLH1Sw&sig2=ZMsqHYjVGvTU_XrTBEH8Iw&bvm=bv.58187178_d.cGU&cad=rja

<http://www.spellmanhv.com/Technical-Resources>

Research Papers

[A High-Power, High-Voltage Power Supply For Long-Pulse Applications](#)

[Accurate Measurement Of On-State Losses Of Power Semiconductors](#)

[Analysing Electric Field Distribution In Non-Ideal Insulation At Direct Current](#)

[Comparative Testing Of Simple Terminations Of High-Voltage Cables](#)

[Comparison Of The Dielectric Strength Of Transformer Oil Under DC And Repetitive Multimillisecond Pulses](#)

[Design And Testing Of A High-Power Pulsed Load](#)

[High-Power High-Performance Low-Cost Capacitor Charger Concept And Implementation](#)

[Highly Efficient Switch-Mode 100 KV, 100 KW Power Supply For ESP Applications](#)

[Behavior Of HV Cable Of Power Supply At Short Circuit And Related Phenomena](#)

"EMP/HERF Shock Pulse Generators", <http://www.amazing1.com/emp.htm> See also <http://www.wnd.com/2012/08/emp-attack-90-of-americans-would-be-dead/> http://en.wikipedia.org/wiki/Norwegian_rocket_incident ("Black Brant scare")

http://en.wikipedia.org/wiki/Able_Archer 83

<http://www.guardian.co.uk/commentisfree/2012/oct/27/vasili-arkhipov-stopped-nuclear-war>

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Techniques", http://ieeexplore.ieee.org/xpl/freeabs_all.jsp?arnumber=149456 (This might be the same article that is in the book by J.C. Martin, chapter 4)

"Ultra-short Pulse Generator", Thomas E. McEwan (1993) [200 picosecond, 100kW pulse] <http://www.freepatentsonline.com/5804921.html>

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Weeks, <http://www.appliedenergetics.com/downloads/technical-papers/design-and-operation-of-a-700-kv-awg.pdf>

"250 kV Sub-nanosecond Pulse Generator with Adjustable Pulse-width", Tammo Heeren, J.

Thomas Camp, Juergen F. Kolb, Karl H. Schoenbach, Sunao Katsuki, Hidenori

Akiyama (2010) <http://ee.cqu.edu.cn/myweb/upfile/20100308174223990.pdf> "The pulse rise-time can be adjusted by manipulation of a peaking gap, whereas the pulse-width can be changed by adjusting a novel tail-cut switch located close to the load."

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(1989) <http://www.alphaomegapt.com/pdf%20files/1989%20Repetitive%20PFN%20Design.PDF>

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"Flexible High Voltage Pulsed Power Supply for Plasma Applications", Sasan Zabihi Sheykhrajeh
(2011) http://eprints.qut.edu.au/48137/1/Sasan_Zabihi_Sheykhrajeh_Thesis.pdf

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"high current 60 KV Multiple Arc Spark Gap Switch of 1.7 nH inductance" <http://www.lw20.com/2011041411643093.html> (see list)

"Design and Simulation of Fast Pulsed Kicker/Bumper Units for the Positron Accumulator Ring at APS",
Ju Wang, Gerald J. Volk, <http://www.osti.gov/bridge/servlets/purl/5935531-6nyvSS/5935531.pdf>

"High voltage microsecond pulse-forming network", (abstract) Kenneth B. Riepe
(1977) http://rsi.aip.org/resource/1/rsinak/v48/i8/p1028_s1

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(1989) <http://www.dtic.mil/dtic/tr/fulltext/u2/a211762.pdf>

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"Compact, High Power, Repetitive Pulsed Power Instrumentation", Dr. Martin A. Gundersen
(2004) <http://www.dtic.mil/cgi-bin/GetTRDoc?AD=ADA419891&Location=U2&doc=GetTRDoc.pdf>

"Magnetic and Electric Effects on Water" <http://www.lsbu.ac.uk/water/magnetic.html> ; <http://www.lsbu.ac.uk/water/anmlies.html>

<http://worldwidescience.org/topicpages/g/generating+gw+power.html#> (This is not a directly useable resource for most readers. But it gives an indication of the state of the technology, as well as hints for search terms. Example: ever heard of an "Enantiomorphic blumlein impulse generator" ? You can get the paper at <http://www.ntis.gov/search/product.aspx?ABBR=DE92016549> ; see

also <http://books.google.com/books?id=0ad-U3QSR1cC&pg=PA129&lpg=PA129&dq=L.+F.+Rinehart&source=bl&ots=IoijnEub-j&sig=3kz4Tis97b5ww-9XPsDrCkekGFo&hl=en&sa=X&ei=k85RUbDhG5CyigLyioGIAg&ved=0CFoQ6AEwBQ#v=onepage&q=L.%20F.%20Rinehart&f=false> ; <http://books.google.com/books?id=0ad-U3QSR1cC&pg=PA129&lpg=PA129&dq=L.+F.+Rinehart&source=bl&ots=IoijnEub-j&sig=3kz4Tis97b5ww-9XPsDrCkekGFo&hl=en&sa=X&ei=k85RUbDhG5CyigLyioGIAg&ved=0CFoQ6AEwBQ#v=onepage&q=L.%20F.%20Rinehart&f=false> (sub-nanosecond pulse generation) ; http://old.elmag.org/lib/exe/fetch.php/wiki:user:machac:texty:motl_protiva.pdf ; etc.)

Center for Pulsed Power and Power Electronics <http://www.p3e.ttu.edu/personnel/JohnMankowski.asp>

"Method of generating a train of fast electrical pulses and applying the pulses to an undulator", Francesco Villa, (Dec 30 2003) <http://www.freepatentsonline.com/6670767.pdf>

"Pulse and waveform generation with Step Recovery Diodes" http://hp.woodshot.com/hprfhelpl/5_downld/lit/diodelit/an918.pdf

Therefore, the output rise time of this circuit can be many times smaller than the rise time of the drive waveform. In practice, a 10 ns pulse rise time can be easily sharpened to 300 ps with a one diode circuit, and to 100 or 50 ps with two and three diode circuits. The detailed design of these circuits is given in Section III.

http://en.wikipedia.org/wiki/Step_recovery_diode :

In electronics, a step recovery diode (SRD) is a semiconductor junction diode having the ability to generate extremely short pulses. It is also called snap-off diode or charge-storage diode or memory varactor, and has a variety of uses in microwave electronics as pulse generator or parametric amplifier.

When diodes switch from forward conduction to reverse cut-off, a reverse current flows briefly as stored charge is removed. It is the abruptness with which this reverse current ceases which characterises the step recovery diode.

The Drift Step Recovery Diode (DSRD) was discovered by Russian scientists in 1981 (Grekhov et al., 1981). The principle of the DSRD operation is similar to the SRD, with one essential difference - the forward pumping current should be pulsed, not continuous, because drift diodes function with slow carriers.

The principle of DSRD operation can be explained as follows: A short pulse of current is applied in the forward direction of the DSRD effectively "pumping" the P-N junction, or in other words, "charging" the P-N junction capacitively. When the current direction reverses, the accumulated charges are removed from the base region.

As soon as the accumulated charge decreases to zero, the diode opens rapidly. A high voltage spike can appear due to the self-induction of the diode circuit. The larger the commutation current and the shorter the transition from forward to reverse conduction, the higher the pulse amplitude and efficiency of the pulse generator (Kardo-Sysoev et al., 1997).

Applications:

Pulsed Power Technology and Applications-Scandinavia, K. Ahlfont, H. Sandborgh (1999)
http://www.energy.ca.gov/process/pubs/pulsed_power_tech_tr112566.pdf (Scandinavia)

"Commercial Pulsed Power Applications in Germany", Markus J. Loeffler,.
<http://hochleistungspulstechnik.fh-gelsenkirchen.de/uploads/media/Paper-PPT-02-37-PST-02-80.pdf> (Germany)

"Pulsed Power Systems for Food and Wastewater Processing", M.P.J. Gaudreau, T. Hawkey, J. Petry, M. Kempkes http://www.divtecs.com/data/File/papers/PDF/EPPC-PEF102202_US.pdf

"Pulse Power Applied to Process Industry and Environment", Shesha H. Jayaram <http://faculty.kfupm.edu.sa/ee/sbaiyat/events/IEEEGCC2007/Jayaram%20invited%20paper.pdf>

Pulsed Electric Fields Technology for the Food Industry: Fundamentals and Applications, Javier Raso-Pueyo, Volker Heinz editors (2006) This book is mostly about the use of Pulsed Electric Fields (PEF) in the food industry. It is not intended as a reference on pulsed power electrical systems design (and indeed, some of the electrical diagrams make no sense, and some terminology suffers from translation problems). PEF can affect permeability of cell membranes and can be used to improve extraction of starch from potatoes, sugar from sugar beets, as well as to considerably reduce bacterial counts in orange juice, apple juice, milk, etc. Additionally, the content does make me start wondering again about reports of using PEF to treat snake and spider bites. See "Electric Shock on Venomous Bites & Stings", <http://venomshock.wikidot.com/>

"Formation of thin films using pulse power and electromagnetic repulsion forces", Yoshihisa Sekiya, Tadahiko Yamada, and Yoshitaka Kondo (2008) *Journal of Applied Physics*, 104, 023305 (2008) ; accessed online thru EBSCO Host via local library account

"Marx Generator, knocks our rocks off", Jakob Griffith (2010) <http://hackaday.com/2010/10/23/marx-generator-knocks-our-rocks-off/> ; <http://www.lucidscience.com/>

"Ion Beam Surface Treatment", <http://www.alphaomegapt.com/pdf%20files/IBEST%20TOPCON%202009.pdf>

"A High-Voltage Pulse Generator for Corona Plasma Generation", K. Yan, E. J. M. van Heesch, A. J. M. Pemen, Member, IEEE, P. A. H. J. Huijbrechts, F. M. van Gompel, H. van Leuken, and Zdenek Matyáš (2002) <http://alexandria.tue.nl/openaccess/Metis148987.pdf>

"Water Fuel Cell", Stanley Meyer <http://www.rexresearch.com/meyerhy/meyerhy.htm>

"Method and Means for Generating Explosive Forces", <http://www.freepatentsonline.com/3680431.html>

<http://www.rexresearch.com/sprink/sprink.htm>

<http://www.rexresearch.com/ravatin/ravatin.htm>

<http://worldwide.espacenet.com/publicationDetails/biblio?CC=FR&NR=2716123>

<http://worldwide.espacenet.com/publicationDetails/biblio?CC=FR&NR=2716123>

Transmission line techniques:

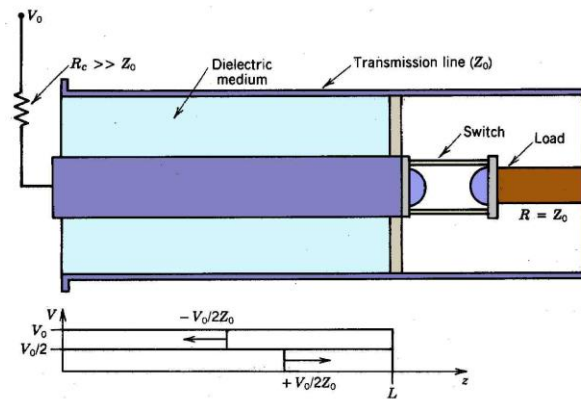


Figure 9.33 Coaxial transmission line used as a square-pulse generator.

Principles of Charged Particle Acceleration, Stanley Humphries, Jr.(1999) p. 249

http://www.lpl.arizona.edu/~guofan/literature/othersort/monograph/principles_of_charged_particle_acceleration.pdf

"Design of a Compact Transmission Line Transformer for High Voltage Nanosecond Pulses", Pawelek, D.B.; Wouters, P.A.A. ; Pemen, A.J.M. ; Kemper, A.H. ; Brussaard, G.J.H.

(2007) <http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=4286523&contentType=Journals+%26+Magazines>

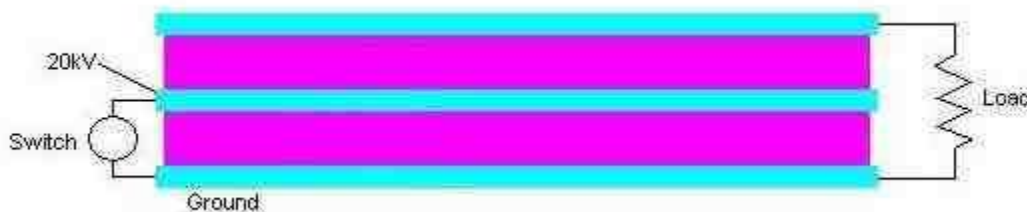


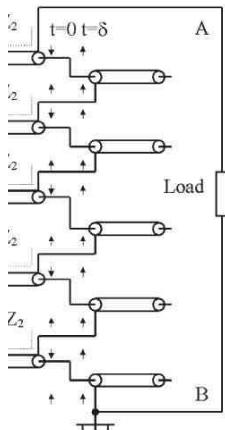
Figure 1 - A Blumlein. The spark gap triggering mechanism is located on the left side and the load is attached to the right side. The center plate is charged to 20 kV and the outside plates are grounded.

("Theoretical Investigation of a laser Triggered Gas Spark Gap", Eric Worts (2005) p. 2)

http://ped.slac.stanford.edu:8080/pem/useful_info/Blumlein.pdf (good tutorial on Blumlein configuration)

<http://www.sparkbangbuzz.com/tealaser/tealaser7.htm> (application to Transversely Excited Atmospheric laser)

<http://192.197.62.35/staff/mcsele/lasers/LasersTEA.htm>



of ten coaxial lines.

"00 A Blumlein Pulser for
Plasma Implantation",
i (2006)
[npe.br/col/sid.inpe.br/
...blumlein.pdf](http://npe.br/col/sid.inpe.br/...blumlein.pdf)

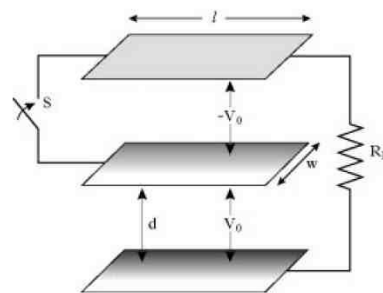


Figure 15: Illustration of a single tri-plate Blumlein composed of two parallel plate transmission lines which share a common conductor.

"A Computational Analysis of Stacker
Blumlein Pulse Generators", Johnelle
Lillian Koriath (1998)
<http://www.utdallas.edu/~cantrell/koriath04.pdf>

MOGUL Blumlein 3.8 Megavolt flash X-ray pulse generator ("the dimensions of this thing gives new meaning to the term 'transmission line' " ! -

BF) <http://books.google.com/books?id=9ORb4YQ6r1YC&pg=PA11&lpg=PA11&dq=Mogul+Blumlein&source=...>

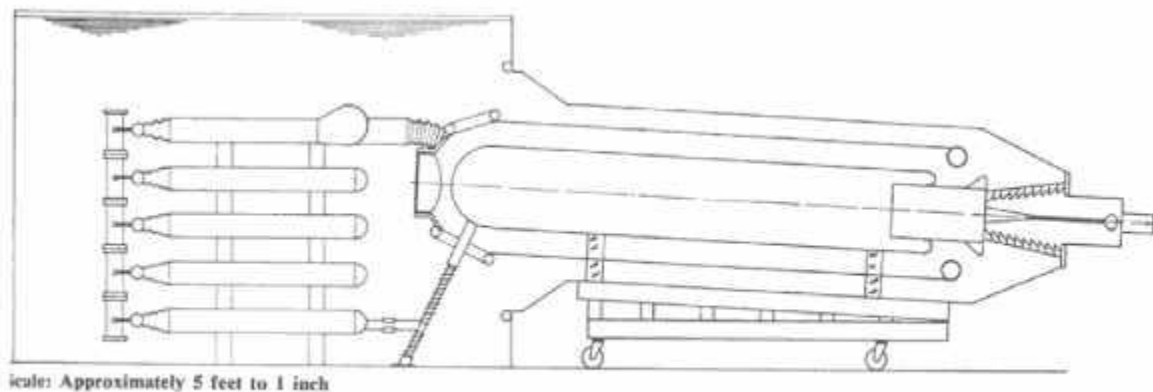


Fig. 1-4 Scaled cross section of Mogul.

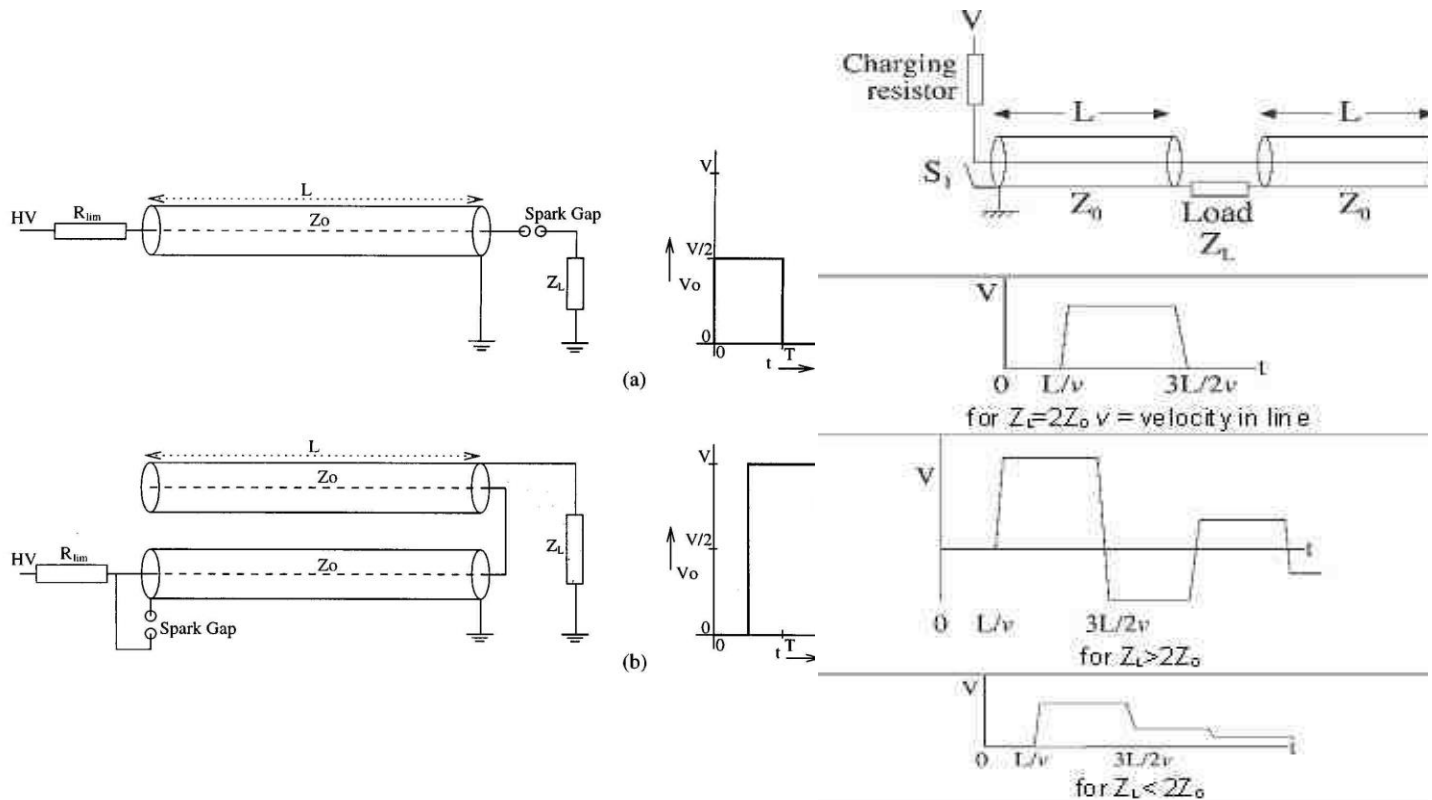
Mogul is a larger oil filled coaxial Blumlein system shown as Figure 1-4. This figure shows a cross sectional view of Mogul. The Marx is located, under oil, on the left, the high speed Blumlein section is in the centre mounted on wheels and the X-ray tube is located in the end of the outer cylinder on the right. The high speed switch is at the left hand end of the Blumlein section mounted between the inner and intermediate cylinders.

J. C. Martin on Pulsed Power, T.H. Martin, M. Williams, M. Kristiansen (2013) p.11

"Design and performance analysis of transmission line-based nanosecond pulse multiplier", Rishi Verma, A. Shyam, and Kunal G. Shah <http://www.ias.ac.in/sadhana/Pdf2006Oct/597.pdf>

"Impulse Electromagnetic Interference Generator", Rishi Verma, A Shyam, S Chaturvedi, R Kumar, D Lathi, P Sarkar, V Chaudhary, Shukla R, K Debnath, S Sharma, J Sonara, K. Shah, B. Adhikary, T Jigna, J

Piyush [http://blockyourid.com/~gbpprorg/mil/herf/Impulse Electromagnetic Interference Generator.pdf](http://blockyourid.com/~gbpprorg/mil/herf/Impulse_Electromagnetic_Interference_Generator.pdf)



"Design and construction of double-Blumlein HV pulse power supply",

Deepak K Gupta and P I John (2000)

<http://www.ias.ac.in/sadhana/Pdf2001Oct/pe941.pdf>

"A Short Tutorial on Transmission Lines in PulseGenerator Systems", Kentech

Instruments Ltd. [http://www.kentech.co.uk/](http://www.kentech.co.uk/transmission_lines/Transmission_lines.html)

[transmission_lines/Transmission_lines.html](http://www.kentech.co.uk/transmission_lines/Transmission_lines.html)

See also: <http://www.ebookpp.com/bl/blumlein-pdf.html> (various listings)

"Multiple-switch pulsed power generation based on a transmission line transformer", Zhen Liu (2008) <http://alexandria.tue.nl/extra2/200712432.pdf>

"Development of a Blumlein based on helical line storage elements", Singal, V. P.; Narayan, B. S.; Nanu, K.; Ron, P. H. (2001) <http://connection.ebscohost.com/c/articles/4717096/development-blumlein-based-helical-line-storage-elements> (An amateur variation on this might be to use a PVC tube as the dielectric and aluminum flashing inside the tube as a substitute for the aluminum tube electrode. Still, Mylar film has repeatedly proven to be the best dielectric generally in these high voltage pulsed power devices.)

"Limitations to Compacting a Parallel-Plate Blumlein Pulse-Forming Line", Miroslav Joler, Christos G. Christodoulou, Edl Schamiloglu (2007); International Journal of RF and Microwave Computer-Aided Engineering DOI 10.1002/mmce ; discusses Length Width Ratio (LWR) effects; accessed online thru EBSCO Host via local library account

<http://www.barc.gov.in/btdg/appd/compact.html>

High Voltage Pulse Transformers:

"Improvements in or relating to high-voltage pulse-generating transformers and circuits for use", Martin, John Christopher; Smith, Ian Douglas (GB1114713, US3456221

) <http://www.freepatentsonline.com/3456221.pdf> (Note the use of "stepped edge configuration" for corona reduction)

"Analysis of Auxiliary Winding Effect on the Leakage Inductance Reduction in the Pulse Transformer Using ANSYS", Khodakarami, Alireza

(2010) <http://www.scirp.org/journal/PaperInformation.aspx?paperID=2764> (JEMAA20100900001_72971999[1].pdf; open access)

"Finite Element Analysis of Leakage Inductance of 3-Phase Shell-Type and Core Type Transformers", Mehdi Zare, Seyyed Mohammad Pedram Razi, Hassan Feshki Farahani and Alireza

Khodakarami (2012) <http://maxwellsci.com/print/rjaset/v4-1721-1728.pdf>

"Rise time reduction in high-voltage pulse transformers using auxiliary windings"

<http://ieeexplore.ieee.org/xpl/login.jsp?tp=&arnumber=988830&url=http%3A%2F%2Fieeexplore.ieee.org%2Fiel5%2F63%2F21304%2F00988830.pdf%3Farnumber%3D988830>

(abstract)

"DC Accelerators",

E.Cottureau <http://cas.web.cern.ch/cas/pruhonice/pdf/dc-accel-DB1.pdf> (see section 3.2: "Insulating Core Transformers")

"Les transformateurs élévateurs de

tension" <http://lyonel.baum.pagesperso-orange.fr/transfo.html> (Ruhmkorff's induction spark coil)

The following articles are about transformer *drivers*, not transformers themselves (they drive transmission line impedance transformers.) These devices are a source of pulsed power, like a Marx generator, except that in the newer designs, they are much more compact, and the pulse is fast enough and powerful enough to be used directly. http://en.wikipedia.org/wiki/Linear_transformer_driver

<http://prst-ab.aps.org/pdf/PRSTAB/v14/i4/e040401>

"Compact 810 kA linear transformer driver cavity",

J. R. Woodworth,* W. E. Fowler, B. S. Stoltzfus, W. A. Stygar, M. E. Sceiford, and M. G. Mazarakis H. D. Anderson and M. J. Harden J. R. Blickem R. ,A. A. Kim (2011)

The following links from the footnotes are helpful for understanding this article:

<http://prst-ab.aps.org/pdf/PRSTAB/v10/i3/e030401>

<http://prst-ab.aps.org/pdf/PRSTAB/v12/i5/e050401>

<http://prst-ab.aps.org/pdf/PRSTAB/v12/i5/e050402>

<http://prst-ab.aps.org/pdf/PRSTAB/v13/i9/e090401>

<http://prst-ab.aps.org/pdf/PRSTAB/v13/i7/e070401>

http://www.lpl.arizona.edu/~guofan/literature/othersort/monograph/principles_of_charged_particle_acceleration.pdf

<http://prst-ab.aps.org/pdf/PRSTAB/v14/i5/e050401>

"250 kA compact linear transformer driver for wire array z-pinch loads",

S. C. Bott, D. M. Haas, R. E. Madden, U. Ueda, Y. Eshaq, G. Collins IV, K. Gunasekera, D. Mariscal, J. Peebles, and F. N. Beg, M. Mazarakis, K. Struve, and R. Sharpe

"High-Current Linear Transformer Driver Development at Sandia National Laboratories", Michael G. Mazarakis, William E. Fowler, K. L. LeChien, Finis W. Long, M. Keith Matzen, D. H. McDaniel, R. G. McKee, C. L. Olson, J. L. Porter, S. T. Rogowski, Kenneth W. Struve, W. A. Stygar, Joe R. Woodworth, Alexander A. Kim, Vadim A. Sinebryukhov, Ronald M. Gilgenbach, M. R. Gomez, D. M. French, Y. Y. Lau, Jacob C. Zier, D. M. VanDevalde, R. A. Sharpe, and K. Ward (2010) http://www.sandia.gov/pulsedpower/prog_cap/pub_papers/05373875Mazarakis.pdf

http://www.sandia.gov/pulsedpower/prog_cap/pub_papers/065811.pdf

<http://prst-ab.aps.org/pdf/PRSTAB/v15/i4/e040401>

Insulating Core Transformers

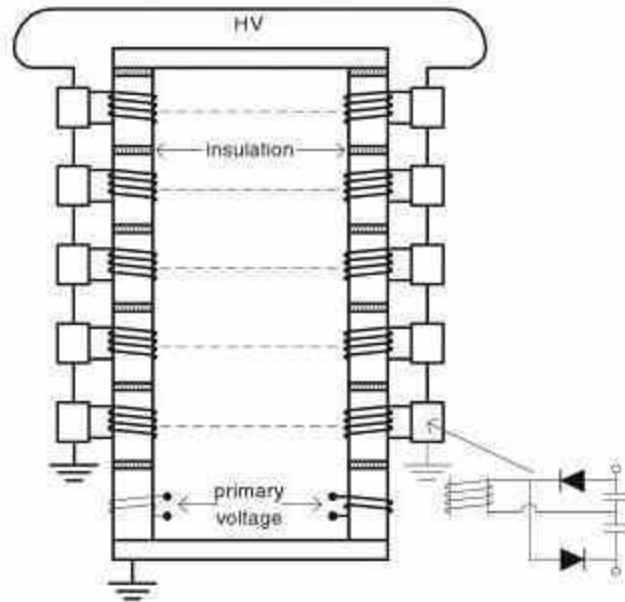


Fig. B3.5. Insulating-core transformer, two phases of the three-phase system are shown in the drawing

Electrostatic Accelerators: Fundamentals and Applications, edited by R. Hellborg (2005) page 108

Wave Erection Marx Generator (<http://www.apelc.com/>) Below is a list of article links copied from the Applied Physical Electronics L.C. site. They are all instructive but only some apply strictly to Marx generators.

"Compact Flash X-Ray For Radiographic Applications," J.R. Mayes (2006) <http://www.apelc.com/pdfs/1.pdf> "Designing the stray elements into the overall design can lead to a "wave erection", in which an electromagnetic wave efficiently propagates the Marx circuit as the switches sequentially close. As a result, ultra fast rise times and high load voltage efficiencies can result."

"Miniature Field Deployable Terahertz Source," M.G. Mayes (2006) <http://www.apelc.com/pdfs/2.pdf>

"An Enhanced MV Marx Generator for RF and Flash X-ray Systems," J.R. Mayes, M.B. Lara, M.G. Mayes & C.W. Hatfield (2005) <http://www.apelc.com/pdfs/3.pdf> "Wave erection is made possible through the proper design of the stray capacitance and the interstage capacitance, in concert with coupling the spark gaps via ultra-violet energy. Rise times from a few hundred ps to several ns result with proper stray element design. "

"A Novel Marx Generator Topology Design for Low Source Impedance," J.R. Mayes, M.B. Lara, & M.G. Mayes (2005) <http://www.apelc.com/pdfs/4.pdf>

"A Modular Compact Marx Generator Design for the Gatling Marx Generator System," J.R. Mayes, M.B. Lara, M.G. Mayes & C.W. Hatfield, et al (2005) <http://www.apelc.com/pdfs/5.pdf>

"High Voltage Properties of Insulating Materials Measured in the Ultra Wide Band," M.G. Mayes, J.R. Mayes, M.B. Lara & L.L. Altgilbers (2005) <http://www.apelc.com/pdfs/6.pdf>

"Subband Encoding By Wavelet Filter Cascade For Bandwidth Compression In FDTD Simulation," M.G. Mayes & C.D. Cantrell (2004) <http://www.apelc.com/pdfs/7.pdf>

"A Compact MV Marx Generator," J.R. Mayes, M.G. Mayes, & M.B. Lara (2004)
<http://www.apelc.com/pdfs/8.pdf> http://www.researchgate.net/publication/4145134_A_compact_MV_Marx_generator

"Compact Pulsed Power Sources," J.R. Mayes & W.J. Carey (2002) <http://www.apelc.com/pdfs/9.pdf>

"The Direct Generation of High Power Microwaves with Compact Marx Generators," J.R. Mayes & W.J. Carey (2002) <http://www.apelc.com/pdfs/10.pdf>

"The Generation of High Electric Field Strength RF Energy Using Marx Generators," J.R. Mayes & W.J. Carey (2002) <http://www.apelc.com/pdfs/11.pdf>

"The Gatling Marx Generator System," 2001 J.R. Mayes, W.J. Carey, W.C. Nunnally & L. Altgibers <http://www.apelc.com/pdfs/12.pdf> (Injection Wave Generators)

"Sub-Nanosecond Jitter Operation of Marx Generators," J.R. Mayes, W.J. Carey, W.C. Nunnally, & L. Altgibers (2001) <http://www.apelc.com/pdfs/13.pdf>

"The Marx Generator as an Ultra Wideband Source," J.R. Mayes, W.J. Carey, W.C. Nunnally, & L. Altgibers (2001) <http://www.apelc.com/pdfs/14.pdf>

"Compact Marx Generators for the Generation of High Power Microwaves," J.R. Mayes, W.J. Carey, W.C. Nunnally, L. Altgibers, & M. Kristiansen (2001) <http://www.apelc.com/pdfs/15.pdf> "This paper discusses two very compact Marx generators capable of delivering voltage pulses of several hundred kV, durations of several nano-seconds to 10's of nanoseconds, and risetimes as fast as 200 ps."

"Analytical Modelling of a Linear GaAs Photoconductive Switch For Short Pulse Excitation," J.R. Mayes & W.C. Nunnally (1999) <http://www.apelc.com/pdfs/16.pdf>

"Spark Gap Triggering with Photoconductive Switches," J.R. Mayes, W.J. Carey & W.C. Nunnally (1999) <http://www.apelc.com/pdfs/17.pdf>

"Photoswitch Material Recombination Effects on the Injection Wave Generator," J.R. Mayes & W.C. Nunnally (1998) <http://www.apelc.com/pdfs/18.pdf> Injection Wave Generator

"Experimental Multiple Frequency Injection-Wave Generator," J.R. Mayes, W.J. Carey & W.C. Nunnally (1996) <http://www.apelc.com/pdfs/19.pdf>

"Design and Performance of an Ultra-Compact 1.8-KJ, 600-KV Pulsed Power System," C. Nunnally., J. R. Mayes, C. W. Hatfield, J. D. Dowden <http://www.apelc.com/pdfs/20.pdf>

"Compact 200-Hz Pulse Repetition GW Marx Generator System," C. Nunnally., J. R. Mayes, T. A. Holt, C. W. Hatfield, M. B. Lara, T. R. Smith <http://www.apelc.com/pdfs/21.pdf>

"A Marx Generator Driven Impulse Radiating Antenna," T. A. Holt, M. G. Mayes, M. B. Lara, J. R. Mayes <http://www.apelc.com/pdfs/22.pdf>

"Compact Marx Generators Modified for Fast Risetime," T. A. Holt, M. B. Lara, C. Nunnally, J. R. Mayes <http://www.apelc.com/pdfs/23.pdf>

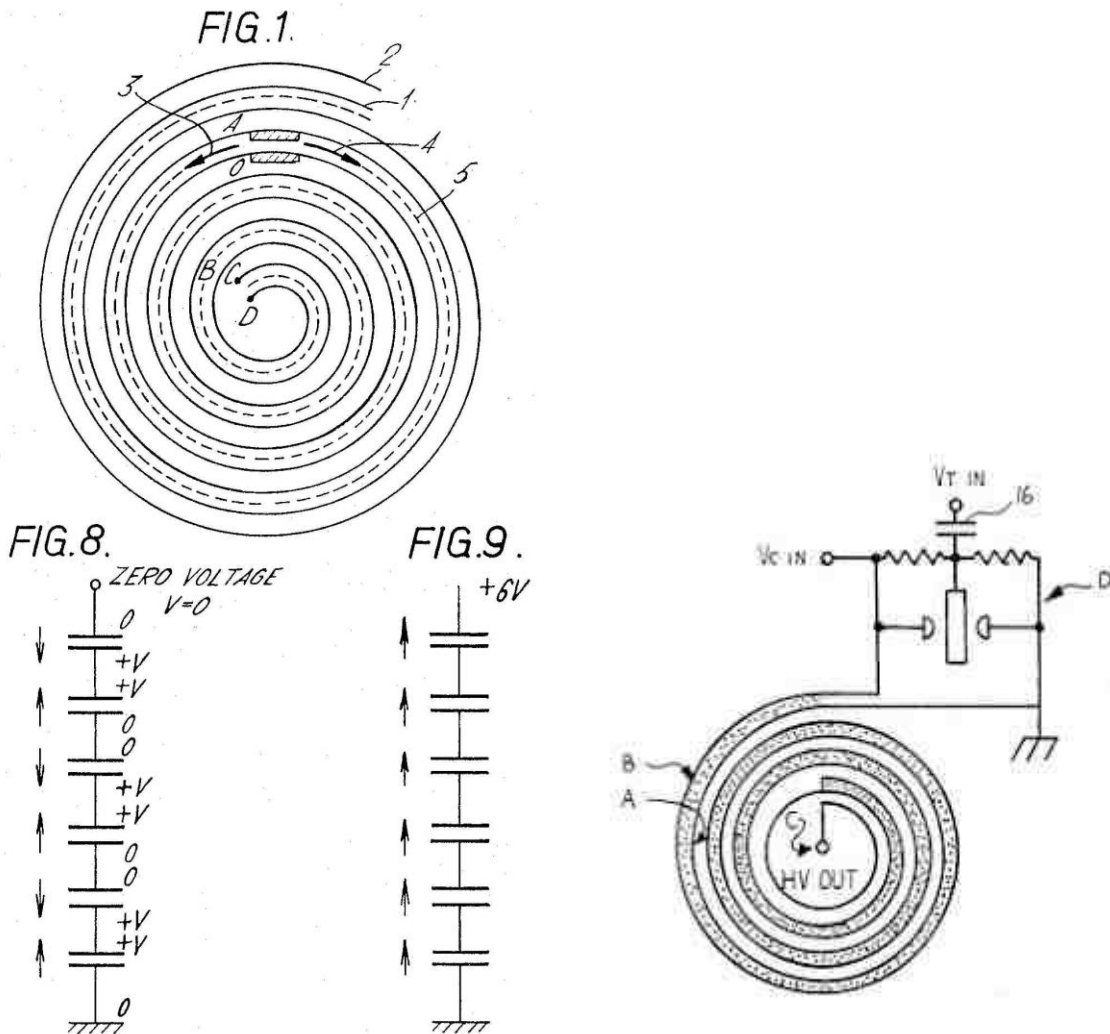
"Development of a Sequentially Switched Marx Generator for HPM Loads," J.R. Mayes and C.W. Hatfield <http://www.apelc.com/pdfs/24.pdf> (the scheme includes simple magnetically saturable switches)

"Helical Antennas for High Powered RF," J.R. Mayes, M.G. Mayes, W.C. Nunnally and C.W. Hatfield <http://www.apelc.com/pdfs/25.pdf>

"An Ultra Portable Marx Generator-Based Solution for MIL STD 461 E/F RS-105 Testing," J.R. Mayes, M.B. Lara, W.C. Nunnally, M.G. Mayes, and J. Dowden <http://www.apelc.com/pdfs/26.pdf>

"High Voltage Surge Generators" http://www.elect.mrt.ac.lk/HV_Chap8.pdf

Spiral Generators (a.k.a. "Vector inversion generators"):



<http://www.freepatentsonline.com/3289015.pdf>
<http://www.freepatentsonline.com/4507567.pdf>

<http://www.freepatentsonline.com/4140917.pdf>

<http://www.freepatentsonline.com/4140917.pdf>
<http://www.freepatentsonline.com/4484085.pdf>

"High Voltage Spiral Generators", A. Ramrus, F. Rose
ftp://ftp.pppl.gov/pub/neumeyer/Pulsed_Power_Conf/data/papers/1976/1976_51.pdf

"Vector inversion generator", Duane C. Lawson
(1982) <http://www.freepatentsonline.com/4507567.pdf>

"Capacitive high voltage pulse generating apparatus", Edward Blank
(1967) <http://www.freepatentsonline.com/3322976.pdf>

"A compact high voltage vector inversion generator" ("Pichugin pulser"),
T. G. Engel, M. Kristiansen <http://libra.msra.cn/Publication/50037737/a-compact-high-voltage-vector-inversion-generator>

"High Efficiency Compact High Voltage Vector Inversion Generators" ,
M. F. Rose, Z. Shotts, Z. Roberts (mentions ferrite loading; See
also <http://www.freepatentsonline.com/7151330.pdf> ; <http://www.freepatentsonline.com/20060238034.pdf>)
http://www.researchgate.net/publication/224280602_High_Efficiency_Compact_High_Voltage_Vector_Inversion_Generators

"Govel-Fitch
generator" <http://www.chipdip.ru/en/video.aspx?vid=ID000305708> ;
"Fitch Impulse Generators" <http://home.earthlink.net/~jimlux/hv/fitch.htm>

"Modified multistage semiconductor-Fitch generator topology with magnetic
compression" http://www.researchgate.net/publication/251858798_Modified_multistage_semiconductor-Fitch_generator_topology_with_magnetic_compression

"Electrical pulse generators", Richard Anthony
Fitch <http://www.freepatentsonline.com/3366799.pdf>

<http://www.barc.gov.in/btdg/appd/compact.html>

<http://www.mirrorsheeting.com/> (a possible source of clear or aluminum
coated mylar sheet)

Magnetically Insulated Voltage Adders (MIVA aka "Induction Adders"):

"Energy Balance of the TW Pulsed Power Generator KALIF-HELIA",
P. Hoppe, J. Singer, H. Bluhm, K. Leber, D. Rusch, O. Stoltz
ftp://ftp.pppl.gov/pub/neumeyer/Pulsed_Power_Conf/data/papers/2001/2001_128.PDF

"Electrical Modeling of Mercury for Optimal Machine Design and Performance Estimation",
R. J. Allen, P. F. Ottinger, R. J. Commisso, J. W. Schumer, T. A. Holta,
P. Hoppe, I. Smith, D. L. Johnson
ftp://zdns.pppl.gov/pub/neumeyer/Pulsed_Power_Conf/data/papers/2003/2003_199.pdf

"A New Linear Inductive Voltage Adder Driver for the Saturn Accelerator", M. G. Mazarakis, R. B. Spielman, K. W. Struve, F. W. Long
<http://arxiv.org/ftp/physics/papers/0008/0008120.pdf>

"RITS-6, A 10-MV Inductive Voltage Adder Accelerator", David L. Johnson, Robert Altes, Vernon Bailey, Patrick Corcoran, Ian Smith, *et al.*
http://www.congress-2006.hcei.tsc.ru/cat/proc_2004/13/Paper_028.pdf (Note: Fig. 10 shows a laser triggered multimegavolt gas switch)

<http://www.techbriefs.com/component/content/article/14145>

"Numerical study of a magnetically insulated front-end channel for a neutrino factory",
Diktys Stratakis, Richard C. Fernow, Juan C. Gallardo, and Robert B. Palmer, David V. Neuffer (2011) <http://www.deepdyve.com/lp/american-physical-society-aps/numerical-study-of-a-magnetically-insulated-front-end-channel-for-a-DJmeYxcVqK>

"Pencil-like mm-size electron beams produced with linear inductive voltage adders", M. G. Mazarakis, J. W. Poukey, D. C. Rovang, J. E. Maenchen, S. R. Cordova, P. R. Menge, R. Pepping, L. Bennett, K. Mikkelsen, D. L. Smith, J. Halbleib, W. A. Stygar, D. R. Welch; Appl. Phys. Lett., Vol. 70, No. 7, 17 February 1997; accessed online thru EBSCO Host via local library account

"Ferrite Line to Decrease Rise Time of Nanosecond Pulses", V. Korchuganov, Yu. Matveev, D. Shvedov
(2001) http://www.researchgate.net/publication/224758736_Ferrite_line_to_decrease_rise_time_of_high-voltage_nanosecondpulses

"Development of Large Size Ferrite Toroids for Fast Magnetic Switching Applications in Accelerators", L. Aditya, P. Pareek, R. S. Shinde, <http://inpac.rrcat.gov.in/downloads/inpac/papers/132%20Revised%20L.%20%20aditya.pdf>

"Long Lines with non-linear parameters" (p. 387) http://books.google.com/books?id=Qs40vx3WB1wC&pg=PA387&lpg=PA387&dq=Katayev+Lines+pulse+forming&source=bl&ots=3sSdC2sKfx&sig=tojXg-uegqKpZg_v2o4KK5Oq1Tw&hl=en&sa=X&ei=7pdaUNGDB-i0igLd1oDABA

[&ved=0CC0Q6AEwAg#v=onepage&q=Katayev%20Lines%20pulse%20forming&f=false](#) :

<http://www.rdmag.com/news/2012/08/magnetic-insulator-shows-way-dissipationless-electronics>

"The Broadcast Power of Nikola Tesla (Part 1)", Gerry Vassilatos, <http://journal.borderlands.com/2010/the-broadcast-power-of-nikola-tesla-part-1/>

"The magnetic arc gap was capable of handling the large currents required by Tesla. In achieving powerful, sudden impulses of one polarity, these were the most durable. Horn shaped electrodes were positioned with a powerful permanent magnetic field. Placed at right angles to the arc itself, the currents which suddenly formed in this magnetic space were accelerated along the horns until they were extinguished. Rapidly extinguished!

Arcs were thus completely extinguished within a specified time increment Tesla configured the circuit parameters so as to prevent capacitor alternations from occurring through the arc space. Each arc discharge represented a pure unidirectional impulse of very great power. No "contaminating current reversals" were possible or permissible."

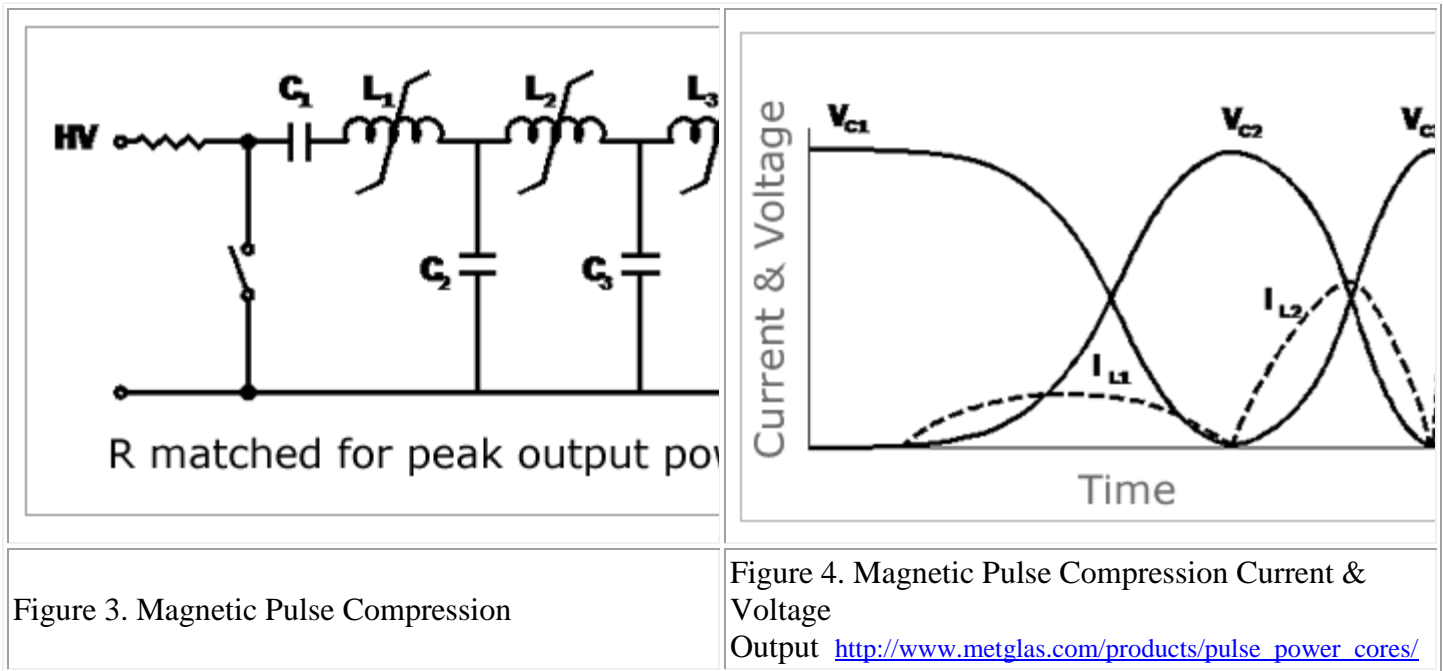
"High Average Power, High Current Pulsed Accelerator Technology", Eugene L. Neau <http://www.osti.gov/energycitations/servlets/purl/79721-6Au3Pe/webviewable/79721.pdf>

The emphasis in these devices is to achieve very high peak power levels, with pulse lengths on the order of a few 10's of nanoseconds, peak currents of up to 10's of MA, and accelerating potentials of up to 10's of MV. New high average power systems, incorporating thermal management techniques, are enabling the potential use of high peak power technology in a number of diverse industrial application areas such as materials processing, food processing, stack gas cleanup, and the destruction of organic contaminants. These systems employ semiconductor and saturable magnetic switches to achieve short pulse durations that can then be added to efficiently give MV accelerating potentials while delivering average power levels of a few 100's of kilowatts to perhaps many megawatts.

Magnetic Pulse Compression

(MPC) http://www.metglas.com/products/pulse_power_cores/

Magnetic Pulse Compression (MPC) utilizes reactors ($L_1, L_2, L_3 \dots$) in conjunction with capacitors ($C_1, C_2, C_3 \dots$) to shape input pulses into narrow output pulses of much higher current (See figure 3 & 4). The MPC, therefore, allows the designer to use less expensive input switches with lower current ratings. MPC can also extend the lifetime of the input switch. Advanced MPC devices - capable of generating power levels of **multi-terawatts in tens of nanoseconds** - have been realized utilizing Metglas® cores.



See also:

"Ferrite Line to Decrease Rise Time of Nanosecond Pulses",
V. Korchuganov, Yu. Matveev, D. Shvedov
(2001) http://www.researchgate.net/publication/224758736_Ferrite_line_to_decrease_rise_time_of_high-voltage_nanosecondpulses

"Development of Large Size Ferrite Toroids for Fast Magnetic Switching Applications in Accelerators", L. Aditya, P. Pareek, R. S. Shinde, <http://inpac.rrcat.gov.in/downloads/inpac/papers/132%20Revised%20L.%20%20aditya.pdf>

"Pulse Sharpening by Magnetic Compression" , George A. Munday
(1991) <http://www.slac.stanford.edu/cgi-wrap/getdoc/slac-pub-5432.pdf>

"The technique of magnetic pulse compression, also called pulse sharpening, has been known and successfully applied for some time.⁷⁻¹¹ A typical application consists of one or more stages of discrete lumped LC lowpass filters forming a delay line as shown in Figure 2. The inductor is designed to magnetically saturate sometime during the leading edge of the drive pulse. The network then "switches" from longer to shorter delay time, which can be made to speed up the leading edge of the transmitted pulse. The later portions of the edge travel faster and "catch up" to the earlier portions somewhat as a water wave steepens in running over a sloping sea bottom. Cascading stages can yield remarkable results with nanosecond risetimes to 50,000 V being reported.^{8,11} Theoretical limits on risetimes of 40 ps per inductance element have been calculated based on the spin relaxation rates in ideal ferrites. When stray reactances in coupled circuits are taken into account this risetime degrades to nanoseconds. A related design is the ferrite-loaded coaxial line,^{10,11} also reported to achieve significant pulse leading edge sharpening. This geometry is basically just a distributed circuit version of the lumped design and operates by the same principles."

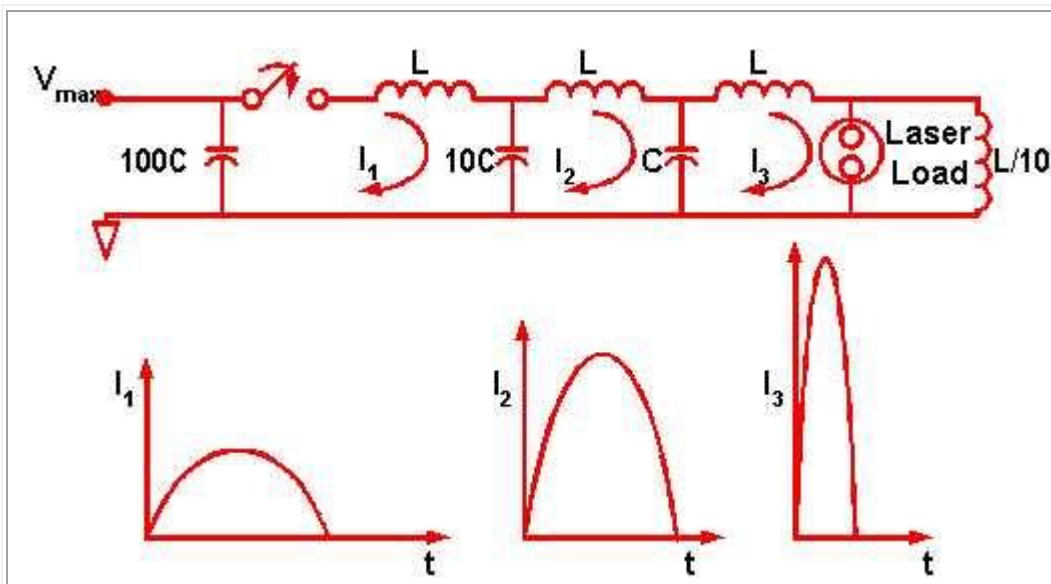
[Abstract] A design approach giving the optimum number of stages in a magnetic pulse compression circuit and gain per stage is given. The limitation on the maximum gain per stage is discussed. The total system volume minimization is done by considering the energy storage capacitor volume and magnetic core volume at each stage. At the end of this paper, the design of a magnetic pulse compression based linear induction accelerator of 200kV, 5kA, and 100ns with a repetition rate of 100Hz is discussed with its experimental results.

"150 kV MAGNETIC PULSE COMPRESSOR" G.Mamaev,
T.Latypov, S.Mamaev, S.Poutchkov, A.Ctcherbakov,
I.Tenyakov Moscow Radiotechnical Institute of Russian
Academy of
Sciences <http://accelconf.web.cern.ch/accelconf/pac97/papers/pdf/7p094.pdf>

"Magnetic pulse compression" <http://russianpatents.com/patent/208/2089042.html>

"Magnetic Cores for Pulse Compression -Magnetics" <http://www.mag-inc.com/File%20Library/Product%20Literature/.../twc-s7.pdf>

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Note that while each stages capacitor value decreases from that of its predecessor, the voltage across it will be twice that upstream. In the case of Figure 2, each inductor core is actually used as a saturating inductor. That is, when the capacitor is fully charged, the energy from that capacitor is dumped into the inductor. As the inductor stores more and more energy allowing its energy to cascade into the next capacitor downstream, and so on.

Core Material Considerations

The ideal core material for these types of saturating inductors should be processed to have:

1. High saturation flux density
2. Low losses
3. Very high interlaminary insulation
4. Very low magnetostriction

Guillemin Type networks

https://docs.google.com/gview?embedded=true&url=http://72.52.208.92/~gbpprorg/mil/radar/gbppr_radar/pulse-forming-networks.pdf

<http://www.alphaomegapt.com/pdf%20files/1989%20Repetitive%20PFN%20Design.PDF>

"Pulse forming network", Radu Motisan (October 9th, 2011 <http://www.pocketmagic.net/?p=2274>

<http://72.52.208.92/~gbpprorg/mil/herf/voltsamps/pfn.html> ("a perfect PFN could be built just from two sheets of metal with a dielectric in the middle." --Slava Persion

Abramyan Networks:

"A Fast, 3 MV Marx Generator for Megavolt oil Switch Testing and Integrated Abramyan Network Design", Laura K. Heffernan

(2005) <https://mospace.umsystem.edu/xmlui/bitstream/handle/10355/4270/research.pdf>

Switches:

"For most applications I prefer the field distortion gap . . . the inductance, is a minimum in this gap and can be cheaply and quickly made. . . also goes by the name mid-plane gap. . ." "Mechanically operated solid gaps have been used for a long time and, for many DC applications, a slightly blunt tin tack and a hammer is by far the best approach. Indeed, this switch probably has the fastest rise time of any when used in a low impedance circuit. . . all in all, it is quite a sophisticated gap." (*J.C. Martin on Pulsed Power*, p. 58; 61-62)

"Fundamental physical considerations for ultrafast spark gap switching", Lehr, J.M.; Baum, C.E.; Prather, W.D.; Torres, R.J. (1998) This paper appears in: *Ultra-Wideband Short-Pulse Electromagnetics 4*, 1998 <http://www.doc88.com/p-8621583218472.html>

Abstract: ". . .an estimate of the fastest risetime achievable with a single channel spark gap has been investigated using three approaches. . . The first two estimates indicate that risetimes on the order of 1-10 ps are achievable. . .To reduce the effect of the intrinsic inductance of the channel, a simple geometrical alteration to the spark gap geometry has been devised which effectively reduces the inductance per unit length of the spark gap to that of its transmission line feed. This simple change alleviates the constraint imposed by the maximum rate of voltage rise and is anticipated to permit the realization of picosecond risetime high power electromagnetic sources." http://www.researchgate.net/publication/3747709_Aspects_of_ultrafast_spark_gap_switching_UWB_HPM_generation

"Fundamental Physical Considerations for Ultrafast Spark Gap Switching", Jane M. Lehr, Carl E. Baum, William D. Prather, Robert J. Torres (1997) <http://rfierro.ecen.ceat.okstate.edu/summa/notes/SwN/SwN28.pdf>

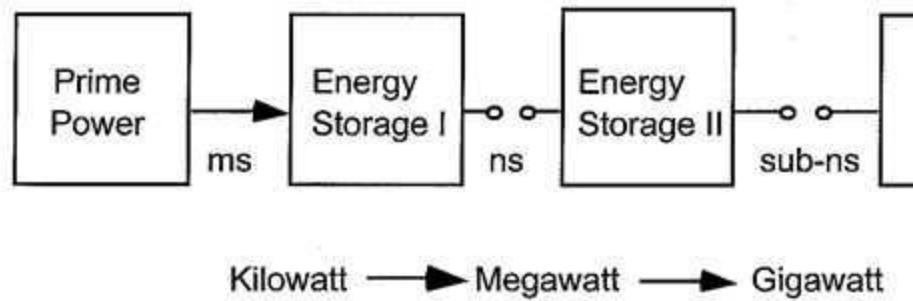


Figure 1. UWB production. Sub-nanosecond duration pulses are successively reducing the timescale at which electrical energy is stored.

"Pulse conditioning systems are being used to generate fast rising electromagnetic fields in the 10s of gigawatt power range. . . . The switching element is a major component of any power conditioning system and, for UWB [Ultra Wide Band] high power electromagnetic field generation, ultrafast closing capability, along with fast voltage recovery are desired. A fast pulse risetime is critical because the risetime contains the high frequency components of the resulting spectrum. To sharpen the rise time on a pulse, a spark gap configuration, called a peaking gap is use. The crux of the peaking gap is the establishment of very high electric fields in the interelectrode spacing. The velocity of propagation of the electron avalanche is proportional to the electric field applied to electrodes, and thus, gap closure is dominated by the applied electric field. To produce ultrafast switching, the spark gap is dramatically overvolted; that is the spark gap is charged far in excess of its self-breakdown voltage. Peaking gaps typically operate at gas pressures in the range of 100 atm and electric fields in the MV/cm range. The self breakdown curve for gases is known to saturate in the vicinity of 100 MV/m for pressures to 50 atm. To achieve overvolting without switching at the self breakdown voltage, the spark gap is pulse charged very quickly. This allows a large overvoltage to be achieved, and overvoltages of over 300% are achievable. . . . Spark channel inductances of less than 1 nH have been achieved with gap lengths of 1 mm and less. . . . These small interelectrode distances, however, yield high spark gap capacitances, even for relatively small diameter electrodes. Moreover, this high spark gap capacitance, and the fast charging times lead to a strong displacement current which manifests as an undesirable prepulse on the load voltage. . . . Since a fast charge is critical to peaking gap operation, small diameter electrodes are desirable. Moreover minimizing the electrode diameter of the peaking gap may lead to enhanced performance. The generation of 50 ps risetime pulse with a 60kV charge in a single channel switch of very small dimensions has been reported."

More about notched and biconical spark gap design:

"The purpose of this taper is to match the impedance of the spark channel to the driving system impedance and hence, matches the inductance per unit length of the hardware to the inductance per unit length of the interelectrode gap region. As shown in Figure 4, the sharp edges introduce additional field enhancement to the spark gap design. A practical design contours both the inner conductor and the outer conductor to maintain a constant impedance as well as the voltage holdoff throughout the switch."

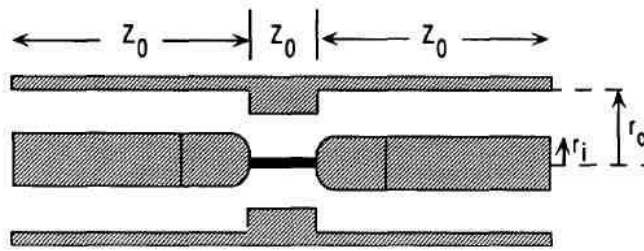


Figure 4. The added dimension of the outer conductor compensates for the reduced impedance of the spark channel radius. This technique matches the impedance of the spark channel to the driving system impedance. The taper dimension is chosen so that the ratio r_o/r_c is equal to the ratio r_o/r_s .

ftp://ftp.pppl.gov/pub/neumeyer/Pulsed_Power_Conf/data/papers/1997/1997_161.PDF

<http://rfierro.ecen.ceat.okstate.edu/summa/notes/SwN/SwN28.pdf>

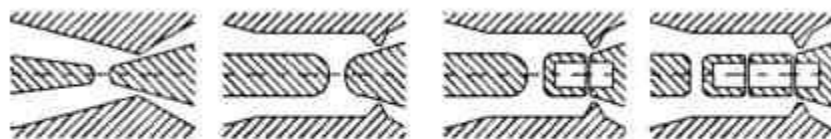


Fig.2. Design performance of electrodes of the peaking and cutoff gas spark gaps.

Ultra-Wideband, Short-Pulse Electromagnetics 4, Joseph Shiloh, Benjamin Mandelbaum (1999) p.2

<http://www.doc88.com/p-8621583218472.html>

"Technology of Fast Spark Gaps", Ronald B. Standler
(1989) <http://www.dtic.mil/dtic/tr/fulltext/u2/a214199.pdf>

"A Durable Gigawatt Class Solid State Pulsed Power System", Frank Hegeler, Malcolm W. McGeoch, John D. Sethian, Howard D. Sanders, Steven C. Glidden, Matthew C. Myers <http://www.appliedpulsedpower.com/wp-content/uploads/hegeler-2011-ieeeetdei.pdf>

"Nanosecond transmission line charging apparatus", James P. O'Loughlin (June 4, 1993) <http://www.freepatentsonline.com/5444308.pdf>

"Precision Variable Delay Using Saturable Inductors", Basting *et al.* <http://www.freepatentsonline.com/6005880.pdf>

"Spark Gap Triggering with Photoconductive Switches", J.R. Mayes, W.J. Carey, W.C. Nunnally <http://www.apelc.com/pdfs/17.pdf>

"Solid State Pulsed Power Systems", Dr. Stephan Roche, http://www.purco.qc.ca/ftp/Steven%20Mark/mannix/solid_state_pulsed_power.pdf

"Pulse Power Switching Devices - An Overview", John Pasley
(1996) <http://home.earthlink.net/~jimlux/hv/pasley1.htm> <http://www.electricstuff.co.uk/pulse.html>

"Repetitive, triggered, long life-time spark-gap switch for pulsed power applications", G.J.J. Winands, Z. Liu, A.J.M. Pemen, E.J.M. van Heesch and K. Yan
(2005) <http://event.cwi.nl/icpig05/cd/D:/pdf/18-221.pdf>

"Femtosecond laser triggering of a sub-100 picosecond jitter high-voltage spark gap", B. M. Luther, L. Furfaro, A. Klix, and J. J. Rocca
(2001) <http://www.engr.colostate.edu/ece/faculty/rocca/pdf/journals/ECEjir00036.pdf>

"Gas-filled laser-triggered spark gap", O. Frolov, K. Kolacek, V. Bohacek, J. Straus, J. Schmidt, V. Prukner (2004) <http://www.ipp.cas.cz/Ips/capil/pdf/%5B40%5D.pdf>

"An Efficient, Repetitive Nanosecond Pulsed Power Generator with Ten Synchronized Spark Gap Switches", Z. Liu, A. J. M. Pemen, R. T. W. J. van Hoppe, G. J. J. Winands, E. J. M. van Heesch, K. Yan <http://alexandria.tue.nl/openaccess/Metis229698.pdf>

<http://www.excelitas.com/Pages/Product/Spark-Gaps.aspx>
<http://www.tesla-coil.com/indsg.htm>

http://members.tm.net/lapointe/Pseudospark_Switch.html

See also [PseudosparkSwitch](#)

Corona Stabilized Switches:

"Corona stabilisation for high repetition rate plasma closing switches", Tuema, F.A. ; MacGregor, S.J. ; Harrower, J.A. ; Koutsoubis, J.M. ; Farish, O.

(1999) <http://ieeexplore.ieee.org/xpl/articleDetails.jsp?reload=true&arnumber=816775&contentType=Conference+Publications>

"Repetitive switching employing corona stabilisation is an effective method for achieving higher PRF operation. Relatively simple designs are available for the self-closing and triggered modes of operation. The self-closing version of these switches has demonstrated good repetitive performance with lifetime capability in excess of 10^8 [10⁸ ?]shots. The triggered version has shown reliable operation at a PRF of up to 20 kHz. The present work has indicated that by selecting the correct electrode geometry and material, it is possible to use corona stabilised switches to achieve performances similar to that of thyratrons at a fraction of the cost"

"A Corona-stabilised Plasma Closing Switch", J. R. Beveridge, S. J. MacGregor, M. J. Given, I. V. Timoshkin, and J. M. Lehr <https://pure.strath.ac.uk/portal/files/472264/IEEE.pdf>

"Corona-stabilised plasma closing switches, filled with electronegative gases such as SF₆ and air, have been used in pulsed-power applications as repetitive switching devices for the last 10 years. Their high repetition-rate capabilities coupled with their relatively simple design and construction have made them suitable alternatives to thyratrons and semi-conductor switches. As well as having repetitive switching capabilities, corona stabilised plasma closing switches have the potential to operate at elevated voltages through the incorporation of multiple electrode sets. This allows high-voltage operation with inherent voltage grading between the electrodes. A further feature of such switches is that they can have relatively low jitter under triggered condition."

"A Novel Design for a Multistage Corona Stabilized Closing Switch", Given, M.J. Timoshkin, I.V. ; Wilson, M.P. ; Macgregor, S.J. ; Lehr, J.M. <http://www.deepdyve.com/lp/institute-of-electrical-and-electronics-engineers/a-novel-design-for-a-multistage-corona-stabilized-closing-switch-8KBFWDDW8O>

"The corona discharge, its properties and specific uses", M. Goldman, A. Goldman, and R. S. Sigmond (1985) <http://www.iupac.org/publications/pac/1985/pdf/5709x1353.pdf>

"Numerical Simulation of Trichel Pulses in a Negative Corona Discharge in Air", P. Sattari, G.S.P. Castle, K. Adamiak (2011) http://www.electrostatics.org/images/ESA2010_K4_Sattari.pdf

<http://sparkbangbuzz.com/corona-osc/corona-osc.htm>

<http://www.physics.usyd.edu.au/~dickm/Positive%20Glow%20Corona.pdf>

http://www.iesj.org/html/service/ijpest/vol3_no1_2009/IJPEST_Vol3_No1_06_pp035-038.pdf

http://www.jspf.or.jp/JPFERS/PDF/Vol8/jpfrs2009_08-0780.pdf

Semiconductor Opening Switch (SOS effect)

"Pulsed power accelerator technology based on solid-state semiconductor opening switches (SOS)", [Kotov, Yu.A.](#); [Mesyats, G.A.](#); [Filatov, A.L.](#); [Lyubutin, S.K.](#); [Alichkin, Ye.A.](#); [Darznek, S.A.](#); [Telnov, V.A.](#); [Slovikovskii, B.G.](#); [Timoshenkov, S.P.](#); [Bushlyakov, A.I.](#); [Turov, A.M.](#) (1994) <http://ieeexplore.ieee.org/xpl/login.jsp?tp=&arnumber=6304397&url=http%3A%2F%2Fieeexplore.ieee.org%2Fiel5%2F6296790%2F6304387%2F06304397.pdf%3Farnumber%3D6304397>

Abstract: In 1991 we discovered a semiconductor opening switch (SOS) effect that occurs at a current density of up to 60 kA/cm². The discovery of the effect provided a basis for the development of an opening switch with a gigawatt level of pulsed power, with an interrupted current of scores of kilo amperes, with a voltage of up to 0.5 MV, and with a current interruption time of 10 to 50 ns. Subsequent to those experiments, we developed a new circuitry ideology of constructing repetitive megavolt generators and accelerators with an all-solid-state switching system. In this approach, the SOS performs the function of a terminal power amplifier, by transforming the microsecond pumping pulse into a nanosecond output pulse. Significantly, the thyristor transformer delivers power to the SOS via an intermediate magnetic compressor. We present results of theoretical and experimental investigations of the SOS effect and describe the circuits and design of accelerators developed on the basis of it.

"What is the SOS effect?", Russian Academy of Sciences, Urals Division, Institute of Electrophysics, http://eng.iep.uran.ru/naudep/imp/napr/nap_13.html (papers: <http://eng.iep.uran.ru/naudep/imp/publ/> ; <http://link.springer.com/content/pdf/10.1134/S106378261204015X#page-1>)

. . . This effect of nanosecond interruption of superdense currents has been termed the SOS effect (Semiconductor Opening Switch)

Thanks to the aforementioned qualities of the SOS effect, powerful nanosecond generators boasting of record-breaking parameters among semiconductor switches were designed already in 2-3 years after the phenomenon had been detected. Using standard rectifier high-voltage columns as a semiconductor opening switch, we developed nanosecond generators having the output voltage up to 1 MV, average power of tens of kW, pulsed current of units and tens of kA, and the pulse power of the gigawatt level

"Generation of High-Power Subnanosecond Pulses", G. A. Mesyats, S. N. Rukin, V. G. Shpak, M. I. Yalandin *Ultra-wideband short-pulse Electromagnetics 4*, editors E. Heyman, B. Mandelbaum, J. Shiloh (1999) <http://www.doc88.com/p-8621583218472.html> (this book has a lot of useful information)

A substantial increase in pulse power and in voltage for semiconductor opening switches was achieved after the discovery, in 1991 of the SOS effect - a nanosecond cutoff of superdense currents in semiconductors . . . SOS diodes have been developed which are nanosecond, solid-state switches intended for interruption of high-density currents. They have an operating voltage of some hundreds of kilovolts and are capable of switching several gigawatts of power and interrupting a current of a few or some tens of kiloamps at kilohertz pulse repetition rates.

Pseudospark Switch

Pseudospark Switch http://en.wikipedia.org/wiki/Pseudospark_switch

"Characterization of high power Pseudospark Plasma Switch (PSS)", BL Meena, SK Rai, MS Tyagi, UN Pal, M Kumar and AK Sharma (2010) http://iopscience.iop.org/1742-6596/208/1/012110/pdf/1742-6596_208_1_012110.pdf

Physics and Applications of Pseudosparks, Martin A. Gundersen, Gerhard Schaefer (1990)

"Recent research has produced a new generation of gas-phase plasma switches that are characterized by very high current emission and conduction while operating in a glow mode. These switches include the pseudospark and the BLT, both of which have hollow electrodes, switch over 10 to 100 kA peak current, and have cathodes with emission $\sim 10,000$ Ncm² over ~ 1 cm² area. The cathode properties are especially remarkable - about 2 orders of magnitude larger emission than existing thermionic cathodes. (Preface)"

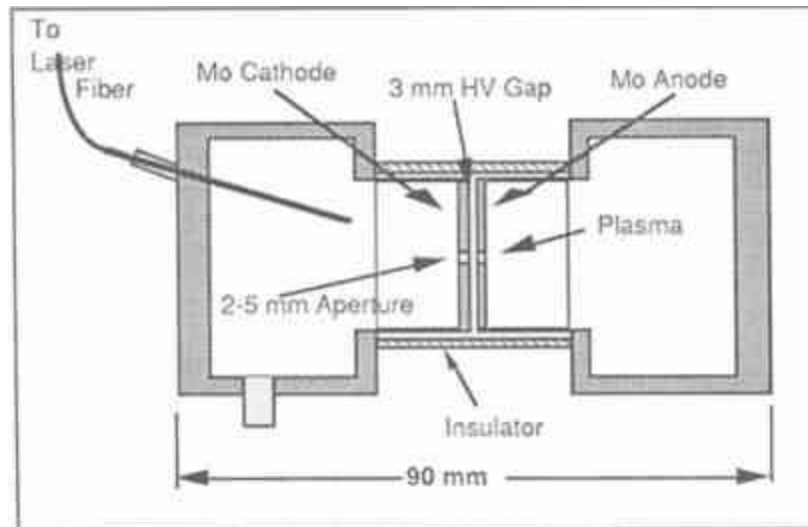
"Electron emission from pseudospark cathodes", André Anders, Simone Anders, and Martin A. Gundersen (1994) http://jap.aip.org/resource/1/japiau/v76/i3/p1494_s1?isAuthorized=no



<http://www.youtube.com/watch?v=vf9c39UfeTU&ebc=ANy...OCizbsIQ>
<http://www2.1-3com.com/ati/pdfs/T-508.pdf>

<http://www.youtube.com/watch?v=vf9c39U>
<http://www2.1-3com.com/ati/pdfs/T-508.pdf>

<http://www.tstnetwork.org/September2011/tst-v4n3-71Pseudospark-sourced.pdf>



http://link.springer.com/content/pdf/10.1007/978-1-4615-3786-1_19.pdf#page-1

(Backlighted Thyatron is similar to a Pseudospark Switch

"Marx Generator Using Pseudospark Switches", Andras Kuthi, Ray Alde, Martin Gundersen, Andreas Neuber http://www-bcf.usc.edu/~kuthi/PPC_2003_Marx_Generator.pdf

"There is a need for high voltage, high current, compact pulsed power sources at the 500 kV, 10 kA, and 500 ns parameter level. Few switches can handle such parameters with any reliability. We have taken two distinct approaches to such a compact pulse generator system. The first is based on the development of a multigap, 200 kV rated Pseudospark switch and Transmission Line Transformers [1], and the other, which we present here, is the Marx generator. Switches in Marx generators need to hold off only a single stage voltage. . . .An excellent candidate switch is the Pseudospark [2,3,4,5]. The Pseudospark is a glow discharge switch, capable of operation at 35 kV and 10 kA, having fast (< 30 ns) rise time, small size and relatively low housekeeping power requirement. . . . [1] Ian D. Smith, "A novel voltage multiplication scheme using transmission lines" Proc. 15th IEEE Power Modulator Symposium, 223-226, (1982). [2] K. Frank, E. Boggasch, J. Christiansen, A. Goertler, W. Hartmann, C. Kozlik, G. Kirkman, C. G. Braun, V. Dominic, M.A. Gundersen, H. Riege and G. Mechttersheimer, "High power pseudospark and BLT switches," IEEE Trans. Plasma Science 16 (2), 317 (1988). [3] "The Physics and Applications of Pseudosparks," NATO ASI Series B 219, Plenum Press (1990) [4] G. Kirkman-Amemiya, H. Bauer, R. L. Liou, T. Y. Hsu, H. Figueroa, and M. A. Gundersen, "A study of the high-current back-lighted thyatron and pseudospark switch," Proceedings of the Nineteenth Power Modulator Symposium, 254 (1990)."

"Basic Mechanisms Contributing to the Hollow Cathode Effect", G. Schaefer, K.H. Schoenbach (Physics and Applications of Pseudosparks, M.A. Gundersen, G. Schafer, eds. (1990)

"If a single plane cathode in a glow discharge is replaced by a cathode with some hollow structure such as a cylindrical or slit shaped hole, then, in a specific range of operating conditions the negative glow is found to be inside the hollow structure of the cathode. Under such conditions at a constant current the voltage is found to be lower and, at a constant voltage, the current is found to be orders of magnitude larger than for the plane cathode. This effect is called the hollow cathode effect (Pashen, 1916). . . .

These switches allow high current densities with unheated cathodes without the usual erosion associated with an arc. They, therefore, have greater lifetimes than spark gaps under similar conditions."

http://en.wikipedia.org/wiki/Paschen's_law ; Cross Field Switch tubes; [Cathode Fall](#) ;

Compact, portable pulsed power: physics and applications. Martin Gundersen, James Dickens and William Nunnally. Available

from: https://www.researchgate.net/publication/4062046_Compact_portable_pulsed_power_physics_and_applications [accessed Nov 10, 2016].

"For high voltage, current, μ sec pulse, and fast rise, pseudosparks deserve study, engineering and development. The USC-TTU-UMC MURI is working collaboratively to accomplish the first stages of this long range need. The physics, and further applications for the beams, of these devices promises fascinating areas of work with productive applications."

"Glow discharge plasma switch controlled by a small magnetic field", J. J. Rocca and K. Floyd (1992) <http://www.engr.colostate.edu/ece/faculty/rocca/pdf/journals/ECEjrr00118.pdf>

"A compact, low jitter, fast rise time, gas-switched pulse generator system with high pulse repetition rate capability", R.J. Focia, C.A. Frost (click on the image) http://www.researchgate.net/publication/224101477_A_compact_low_jitter_fast_rise_time_gas-switched_pulse_generator_system_with_high_pulse_repetition_rate_capability

"Investigation of a Laser Triggered Spark Gap", Winston K. Pendleton, Arthur H. Guenther <http://www.ece.unm.edu/summa/notes/SwN/SwN1.pdf>

"A simple laser-triggered spark gap for kilovolt pulses of accurately variable timing", D. J. Bradley, J. F. Higgins, M. H. Key, S. Majumdar <http://www.springerlink.com/content/1171562931749751/?MUD=MP>

"The Evolution of the Hydrogen Thyatron", C.A.Pirrie and H. Menown <http://aobauer.home.xs4all.nl/Evolution%20of%20Hydrogen%20Thyatron.pdf>

"E2V Technologies Hydrogen Thyatrons Preamble" (2002) http://www.e2v.com/e2v/assets/File/documents/thyatrns/thyatron_preamble.pdf

Thyatron Radar Modulator, <http://www.radartutorial.eu/08.transmitters/tx06.en.html>

Capacitors:

<http://www.ga-esi.com/support/ep/tech-bulletins/high-energy-density-capacitors-for-pulsed-power.pdf>

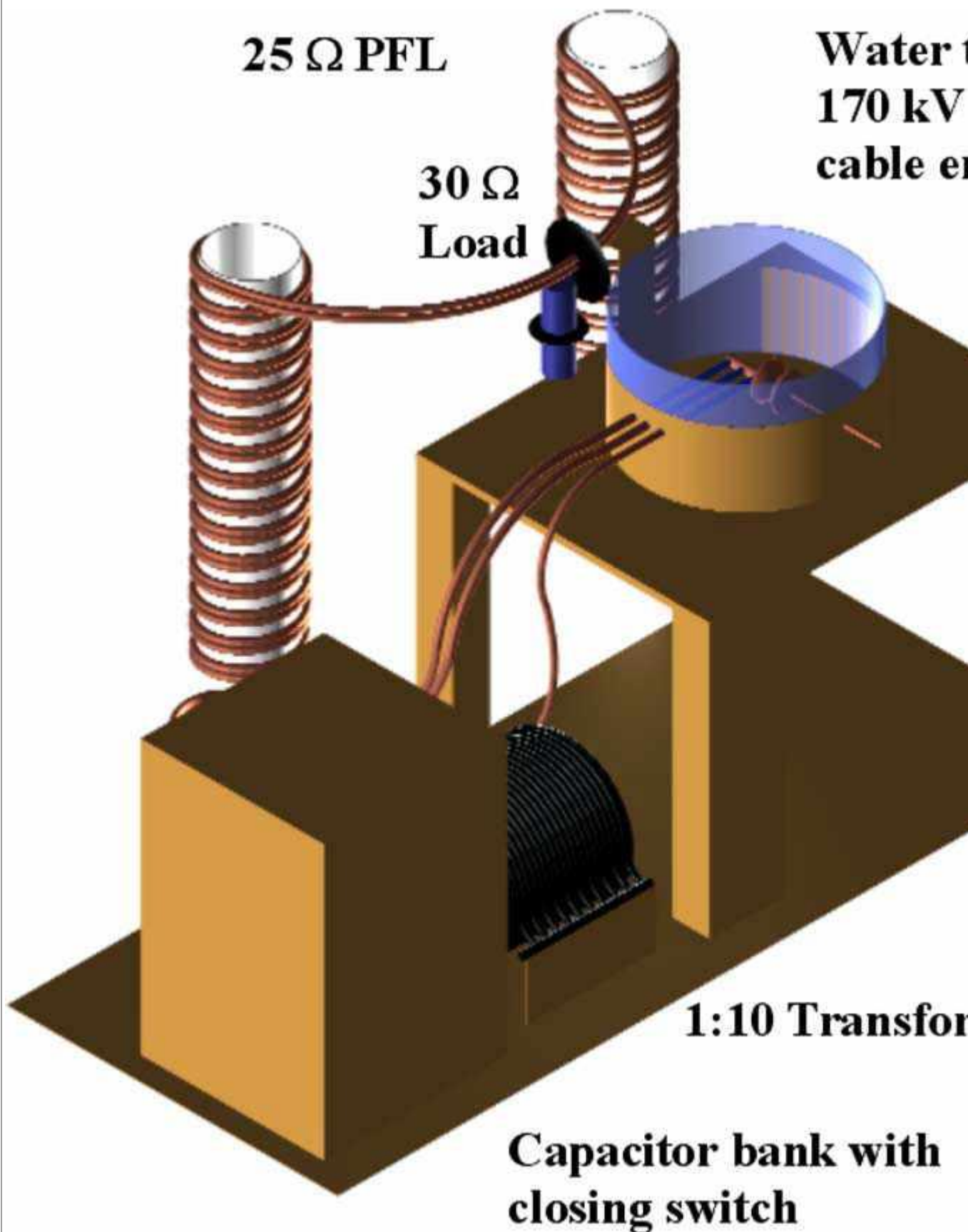
"High voltage impulse generator", Kulikov, Lagunov, Nesterikhin, Fedorov, 1971: <http://www.freepatentsonline.com/3558908.pdf> "Since the spark gap is of a controlled type, the capacitor operates as a transmission line. Because of this, the rate of rise of the current can be readily increased, since the internal impedance of the transmission line is purely resistive. . . . The water capacitor produces a negative voltage pulse of 250 kilovolts at 250 kiloamperes with a rise time of 50 nanoseconds." **(that's a pulse power of about a billion billion watts (1.25 x 10¹⁹ watts) !-BF)**

"100 kV Capacitor Development for Fast Marx Generators", Robert A. Cooper, J.B. Ennis, W. J. Gratza, Richard Miller, S. K. Lam, Peter S. Sincerny (2003) <http://www.ga-esi.com/support/ep/tech-bulletins/fast-marx-generator-capacitors.pdf>

"An Inductive 700-MW High-Voltage Pulse Generator", Adam Lindblom, Hans Bernhoff, Jan Isberg, and Mats Leijon (2006) IEEE TRANSACTIONS ON PLASMA SCIENCE, VOL. 34, NO. 5, OCTOBER 2006 p. 1838 [https://www.academia.edu/9500588/An Inductive 700MW High-Voltage Pulse Generator](https://www.academia.edu/9500588/An_Inductive_700MW_High-Voltage_Pulse_Generator)

Abstract—

A repetitive inductive 700-MW high-voltage pulse generator that delivers a 150-ns square pulse with 20-ns rise time at 150 kV has been constructed. The pulse generator has a 1:10 air core transformer connected to a 25- Ω pulse forming line (PFL). The transformer and the PFL are both constructed using highvoltage cables. The closing switch of the PFL is a spark gap that is in a water tank together with the cable endings of the PFL and transformer. The electric field at the cable endings is refractively graded by



the high permittivity of the surrounding water. The PFL is charged in 2.5 μ s to 170 kV, and the electric field in the closing switch of the PFL reaches 33 kV/mm until the threshold voltage is exceeded. The efficiency of the pulse generator is 40%. The authors believe that this concept can be up-scaled to a 25-GW generator operating at 500 kV. An electric circuit simulation of a 25-GW pulse generator and an electrostatic simulation for a refractive cable ending are presented.

Peaking Capacitors:

http://books.google.co.uk/books?id=spZ_H4nwIN0C&pg=PA18&lpg=PA18&dq=marx+generator+peaking+capacitor

Links: Interesting tutorials on general electrical topics

<http://www.electrotechnik.net/2012/04/video-on-technology-of-high-voltage-dc.html>

<http://www.electrotechnik.net/2010/10/construction-of-transformer.html>

<http://www.electrotechnik.net/2012/05/animation-of-circuit-breaker.html> (high voltage, live load breakers)

<http://www.electrotechnik.net/2012/04/single-phase-pole-mounted-distribution.html>

http://www.youtube.com/watch?v=7tEsJ-xAoEQ&feature=player_embedded (electric motor rewind)

http://www.youtube.com/watch?v=kjbsa1kHj2c&feature=player_embedded (power factor)

<http://www.electrotechnik.net/2012/04/tan-delta-power-factor-testing-video.html>

<http://gallery.bostonradio.org/2004-07/ord/100-02158-med.html> (Austin Transformers)

"Distributed Series Reactance" <http://www.ece.cmu.edu/~electricconf/2008/PDFs/Divan.pdf>

"Active Smart Wires: An Inverter-less Static Series

Compensator" http://www.smartwiregrid.com/docs/Smart_Wire_2.pdf

[http://www.electrotechnik.net/2013/06/the-ferranti-surge-](http://www.electrotechnik.net/2013/06/the-ferranti-surge-absorber.html)

[absorber.html](http://www.electrotechnik.net/2013/06/the-ferranti-surge-absorber.html) , <http://www.freepatentsonline.com/2233939.pdf>

<http://www.electropedia.org/>

http://www.energy.siemens.com/hq/pool/hq/power-transmission/high-voltage-products/capacitors/power-capacitors-capacitor-and-banks_en.pdf

Links-Other:

[PropyleneCarbonateCapacitor5.doc](#) (untested)

<http://www.dtic.mil/ndia/2009fuze/IVAbaginski.pdf>

Micro Glossary

BLT (Back Lighted Thyatron)

BWO (Backward Wave Oscillator)

CARM (cyclotron auto-resonance maser)

Cherenkov maser

<http://www.osti.gov/scitech/biblio/6146069-cherenkov-maser-operation-lower-mm-wavelengths> <https://www.deepdyve.com/lp/institute-of->

electrical-and-electronics-engineers/w-band-cherenkov-maser-based-on-a-periodic-surface-field-structure-ObGNmvfPRa

Dickey superradiation effect <https://en.wikipedia.org/wiki/Superradiance>

DPFL (Double Pulse Forming Line) http://www.hcei.tsc.ru/conf/2010/cat/proc_2008/shce/360-363.pdf

DSRD (Drift Step Recovery Diode; see [above](#))

DTDR (dynamic time-domain reflectometry)

FEL (Free Electron Laser)

HCD (Hollow Cathode Discharge)

LTD (Linear Transformer Driver)

MICD (Magnetically insulated coaxial diode)

TLT (Transmission Line Transformer)

Conclusion

This web page started with an experiment. It began with my naïve attempts at constructing and testing a DC water capacitor. I was not particularly successful in meeting my intended objective. But then I started to learn a lot about pulsed power. That effort led to fascinating concepts like magnetic insulation, flux excluders, saturable magnetic switches, electrostatic grading, parapotential impedance, e-folding rise times, Blumlein, spiral, and vector inversion generators, surface tracking, Rogowski profiles, growth of metallic whiskers, charge storage annealing, backfiring, prepulse, corona switches, and so on.

J. C. Martin's book explained clever building techniques such as how to build a 4 megavolt, 20 kilojoule pulse transformer that is 12 inches in diameter and 18 inches high. How do you handle *that* kind of voltage in such a small package? What tricks do you use to reduce fringing fields and stray inductance in such a transformer? His journey likewise had some interesting detours:

“... started with an experiment . . . a meter wide 3 meter long mylar insulated DC charged Blumlein generator. . . It was switched by a hammer-operated blunt tin tack (US usage thumb tack) which was estimated to switch 2 MA [mega-amps] with a rise time of perhaps 5 ns. The objective was to take the 50 kV pulse in the 1/20 of an ohm output line and stack this in a transit time isolated pulse adder and generate a 1 or 2 MV output pulse into a hundred ohms or so.

I can well remember the result of the first test. The line was charged with absolutely no trouble and only a little crackling to the full 50kV. Having charged it to the full voltage so easily there seemed to be little point in not firing the machine. There was the usual noise of the hammer hitting the tin tack and, in addition, a sharp crack. About 50 small columns of smoke rose through the freon all round the edge of the lines. Far from being depressed at the apparent failure of our first test, I was delighted that we had accidentally stumbled on a multi channel solid dielectric switch.

Indeed this was a constant theme of the early work of the group. If the experiment worked, that was fine. If it did not, which was usually the case, you simply changed the objective of this experiment and considered

exploiting the unexpected occurrence.” (*J.C. Martin on Pulsed Power*, John Christopher Martin, Thomas H. Martin, Arthur Henry Guenther, Magne Kristiansen (1996) p. 21-22)

It is my hope that hobbyists who pursue this science will not be content with just "making sparks" —the adult version of kids playing with matches—but will find applications that are practical and commercial, as well as exploit some truly startling discoveries along the way.

Test Cell for Poynting Vector Experiments

[future topic ? Three articles suggest a need for a such test cell. See [Poynting vector insights](#), [pulsed fields](#), and [Poynting Vector Reversal](#)]

<http://scripturalphysics.org/4v4a/CapacitorTests/CapacitorTests.html>

Rate this web site with the NASA Breakthrough Propulsion Physics (NASA BPP) criteria

The Problem

What is presented at this web site is very different in some key respects from what you think of as "standard physics." You will quickly be confronted with the question "Is this break-through physics or junk science? And how can I tell?"

It turns out that the National Aeronautics and Space Administration (NASA) has a similar problem in its Breakthrough Propulsion Physics program (BPP), and on essentially the same topics that I am trying to cover:

Another challenge of seeking breakthroughs is ensuring credibility without sacrificing openness to new perspectives. This is particularly challenging since genuinely new ideas often extend beyond the established knowledge base, or worse, can *appear* to contradict this base. In other words, a *genuinely* new, credible idea is very likely to *appear* non-credible. Also, it is common when soliciting new ideas to receive a large number of "fringe" submissions that are certainly non-credible. To address this challenge, it is recommended to: (1) concentrate on credible *empirical* data (how nature is observed to work) rather than depending on current theories or paradigms (how nature is *interpreted* to work), (2) compare the new idea's value to existing approaches, (3) ensure that the new idea can be put to a test, and (4) look for the characteristic signs of non-credible science [34]. It should be noted that these credibility criteria do not check if an idea is *correct*, but rather check to see if the idea is credibly constructed and is leading to a correctness test.

Some of the characteristics of non-credible work is that references are not explicitly cited, and that conclusions are made without substantiating the work with supporting evidence. This can be easily checked by requiring that submissions cite credible, peer reviewed, references. References are required for supporting evidence (criteria E), and for comparisons to existing theories (criteria F). Fringe or pathological researchers often do not do this homework. These credibility checks still leave plenty of room for unconventional, visionary ideas. (http://www.bibliotecapleyades.net/ciencia/secret_projects/project301.htm)

My web site (<http://scripturalphysics.org>) was never intended to be a NASA project and of course has no connection with NASA. I write it in my spare time as a hobby. It is intended for those who "like science" and who probably read magazines like Scientific American and Popular Science. Because it has been pieced together over a period of years, it is a bit disjointed and requires a

certain amount of patience to read. But aside from that, I believe it would rate well on the issues that are central to the NASA BPP project (mass, speed, energy) and on methodology, references, credibility, new physics, etc. In the NASA Criteria List (below) I think it scores very well on A,B,C,D,E,G (F is out-of-scope). Of course, no tasks were intended or defined, but if some were, I think they would also rate well on H through N (you can probably get a feel for this one by reviewing the actual research I cite in the references).

If you would like to contribute your own brief review, please do the following:

1. Read all of the NASA document (<http://www.grc.nasa.gov/WWW/bpp/TM-1998-208400.htm> , http://www.bibliotecapleyades.net/ciencia/secret_projects/project301.htm)
2. Read all of my web site (a once-through at <http://scripturalphysics.org>)
3. Write a few paragraphs of your thoughts and impressions and mention "NASA BPP criteria"
4. Also tell me if you want to see more (or less) of "Scriptural Physics".

Please mail your comments to me at: Brian Fraser, P.O. Box 427, Scottsdale, Arizona, 85252

Brian Fraser

Dec 2002

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Assorted excerpts from the NASA document (<http://www.grc.nasa.gov/WWW/bpp/TM-1998-208400.htm> , http://www.bibliotecapleyades.net/ciencia/secret_projects/project301.htm)

In 1996, NASA established the Breakthrough Propulsion Physics program to seek the ultimate breakthroughs in space transportation: propulsion that requires no propellant mass, propulsion that attains the maximum transit speeds physically possible, and breakthrough methods of energy production to power such devices. . .

As the name implies, this program is specifically looking for *propulsion breakthroughs* from *physics*. It is not looking for further *technological* refinements of existing methods. . . . Instead, this program looks beyond the known methods, searching for further advances in science from which *genuinely new* technology can emerge - technology to surpass the limits of existing methods.

...

The first step toward solving a problem is to define the problem. To determine the specific technical goals of the program, the "Horizon Mission Methodology" [32] was used. This method forces paradigm shifts beyond extrapolations of existing technologies by using *impossible* hypothetical mission goals to solicit new solutions. By setting impossible goals, the common practice of limiting visions to extrapolations of existing solutions is prevented. The "impossible" goal used in this exercise was practical interstellar travel. From conducting this exercise, the three major barriers to practical interstellar travel were identified and then set as the program's technical goals. These are *the* breakthroughs required to revolutionize space travel and enable interstellar voyages:

(1) MASS: Discover new propulsion methods that eliminate or dramatically reduce the need for propellant. This implies discovering fundamentally new ways to create motion, presumably by manipulating inertia, gravity, or by any other interactions between matter, fields, and spacetime.

(2) SPEED: Discover how to attain the ultimate achievable transit speeds to dramatically reduce travel times. This implies discovering a means to move a vehicle at or near the actual maximum speed limit for motion through space or through the motion of spacetime itself (if possible, this means circumventing the light speed limit).

(3) ENERGY: Discover fundamentally new modes of onboard energy generation to power these propulsion devices. This third goal is included since the first two breakthroughs could require breakthroughs in energy generation, and since the physics underlying the propulsion goals is closely linked to energy physics.

...

4.1 Research Prioritization Criteria List:

This list shows those factors that would be scored to measure the relative value and progress of research. Each of the lettered criteria below would receive a numeric score which would then be combined to arrive at a total score for a given research approach.

- Relevance To Program:

- A. Directness (must seek advances in physics that are relevant to propulsion or power).
- B. Magnitude of potential gains for goal #1 (mass) + goal #2 (speed) + goal #3 (energy).

- Readiness:

- C. Level of progress achieved to date (measured using the scientific method levels).
- D. Testability (ease of empirical testing).
- [Note: experiments are considered closer than theory to becoming technology].

- Credibility: [Note: these are designed to insure credibility while still being open to visionary ideas]

- E. Fits credible data (references **must** be cited).
- F. More advantageous to program goals than current approaches (references of competing approaches **must** be cited).
- G. Discriminating test suggested.

- Research Task Factors:

- H. Level of progress to be achieved upon completion of task (measured using the scientific method levels).
- I. Breadth of work (experiment, theory, and/or comparative study).
- J. Triage (will it be done anyway or must this program support it?).
- K. Lineage (will it lead to further relevant advancements?).
- L. Time required to complete task (reciprocal scoring factor).
- M. Funding required (reciprocal scoring factor).
- N. Probability of successful task completion (based on credentials and realism of proposal).

Research Funding is Available

If you or your company can do some innovative research in these areas (propellantless propulsion, advanced atomic energy, or third-generation physics) you might consider writing some proposals and requesting funding from an appropriate agency such as:

<http://www.acq.osd.mil/sadbu/sbir/>

Small Business Innovation Research Small Business Technology Transfer

- The Department of Defense (DoD) SBIR and STTR programs fund a billion dollars each year in early-stage R&D projects at small technology companies-- projects that serve a DoD need and have commercial applications.
- Small companies retain the intellectual property rights to technologies they develop under these programs.
- Funding is awarded competitively, but the process is streamlined and user-friendly.

See also:

<http://sbir.gsfc.nasa.gov/SBIR/SBIR.html>

<http://www.sba.gov/sbir/>

Funding in the field of education may be easier to obtain and should also be considered. The material at this [Scriptural Physics](#) web site could be developed further and taught either as third-generation physics or as a class in religion. Second year, semester length, college level classes could be offered on topics that stress exciting applications like:

Fundamentals of Advanced Space Propulsion Physics

Fundamentals of Advanced Space Propulsion Astrophysics

Fundamentals of Hyperspace Navigation

Introduction to Third Generation Physics

These courses *cannot* be a rehash of conventional physics. Nothing even close to these concepts is currently available in any college level courses.

See also the student essay: [One Christian's Perspective on Quantum Mechanics](#) and [An Overview of the Nature of Time](#) .

Educate our educators. See Brian Fraser's comments at:

<http://www.universetoday.com/108044/why-einstein-will-never-be-wrong/>

<http://www.universetoday.com/78558/albert-einsteins-inventions/>

[http://www.universetoday.com/120146/animated-explainer-on-the-fermi-paradox-from-kurz-
gesagt/](http://www.universetoday.com/120146/animated-explainer-on-the-fermi-paradox-from-kurz-gesagt/)

https://asunews.asu.edu/20110921_10000solutions

Books:

Frontiers of Propulsion Science, Marc G. Millis (Editor), Eric W. Davis (Editor), 2009

Internet Comments:

http://cosmiclog.msnbc.msn.com/_news/2010/09/16/5118339-visualize-future-spaceflight?threadId=1076574&commentId=17598040#c17598040

http://cosmiclog.msnbc.msn.com/_news/2010/10/01/5215017-scrunched-up-dimensions-untangled?threadId=1092183&commentId=18117687#c18117687

http://cosmiclog.msnbc.msn.com/_news/2010/08/20/4939982-going-to-mars-itll-be-one-wild-trip (comment #13)

http://technology-science.newsvine.com/_news/2010/10/21/5330993-the-best-options-for-flying-to-faraway-stars?threadId=1110755&commentId=18682551#c18682551

http://cosmiclog.msnbc.msn.com/_news/2010/12/03/5575877-could-x-particle-solve-two-puzzles?threadId=1147914&commentId=19902222#c19902222

http://cosmiclog.msnbc.msn.com/_news/2011/07/01/6994777-inside-nasas-skunk-works-lab?threadId=3164596&commentId=55575609#c55575609

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http://scripturalphysics.org/do_review.html

Brian Fraser's Adventures in Energy Destruction

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(see [permissions](#))
last modified 8-16-16d

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Key words: nuclear waste radioactive storage disposal repository neutralization remediation spent fuel reprocessing

Currently, the United States is constructing a nuclear waste facility at Yucca Mountain, Nevada. It will cost \$57 billion (not including cost overruns) and serves only to STORE radioactive waste instead of neutralizing it. The waste must be transported by rail from 103 reactors, most of which are on the east coast. Transporting such extremely dangerous material from locations all over the country has raised serious safety concerns, especially since the events of September 11, 2001. And the storage site will have to be defended against intrusions and accidents for thousands of years. (see Nevada's Nuclear Waste Project Office at <http://www.state.nv.us/nucwaste/> . Various other links: *Radioactive Roads And Rails: Hauling Nuclear Waste Through Our Neighborhoods*, <http://uspirg.org/uspirg.asp?id2=7242&id3=USPIRG&> ; <http://www.citizenalert.org/> ; <http://www.mapscienc e.org/> ; <http://www.osti.gov/bridge/> <http://www.radwaste.org/> ; <http://www.world-nuclear.org/info/inf69.html>, <http://members.cox.net/theroyprocess/litaleearticle.html> , http://belfercenter.ksg.harvard.edu/publication/2089/economics_of_reprocessing_vs_direct_disposal_of_spent_nuclear_fuel.html ; <http://www.million-against-nuclear.net/background/6reasons.htm>)

The Yucca Mountain project was cancelled by president Obama in 2009. The Federal government is supposedly looking into alternatives now:

The time is long overdue for America to find a new approach for solving the nation's nuclear waste problem. That is why I was joined by Senator John Ensign in proposing the creation of a [Blue Ribbon Commission](#) of experts to make credible, scientifically sound recommendations for a new approach to nuclear waste.

I am pleased that President Obama and Secretary Chu agree with this approach, and on March 3, 2010, announced the creation of the [Blue Ribbon Commission on America's Nuclear Future](#). The commission includes distinguished nuclear energy experts, geologists, policymakers, and environmental policy experts. The panel will present their final report on the best alternatives to Yucca in early 2012. While this commission prepares its report, I will ensure that Nevada's health and safety are never again threatened by nuclear waste. <http://reid.senate.gov/issues/yucca.cfm>

See [my comments to the BRC](#) (and add your own!). Another good read is: *Nuclear Roulette the Case Against a "Nuclear Renaissance"*, Gar Smith, http://ifg.org/pdf/Nuclear_Roulette_book.pdf

On-site neutralization of radioactive waste at the power plant would make a lot more sense if the option were in fact available. Currently it is not. Scientists generally believe that radioactive decay rates are remarkably constant and that they cannot be changed by a simple, inexpensive process. The discovery of so-called "cold fusion" in 1989, however, changed all that. It became clear that radioactive decay rates could be affected by ordinary electrolysis. This led some scientists to propose that a process be developed for disposal of radioactive waste. Dr. G.H. Miley, for example,

wrote U.S. Department of Energy Nuclear Energy Research Initiative (1999), Proposal No. 99-0222, "Scientific Feasibility Study of Low-Energy Nuclear Reactions (LENRS) for Nuclear Waste Amelioration".(<http://papers.sae.org/1999-01-2725/>) The proposal was actually accepted, but some of those "institutionalized, atherosclerotic precision mound builders" that I talk about, later killed the project. Apparently, this was just too big a mound for them to leap over. (See: <http://www.youtube.com/watch> <http://www.infinite-energy.com/iemagazine/issue28/criticskill.html> , http://web.pdx.edu/~pdx00210/News/CFRLEngNews/CFRLE_N05.htm , Complaints about U.S. Office of Patents and Trademarks regarding Cold Fusion: <http://www.padrak.com/ine/POLETT899.html> , Transcript of ABC's "Good Morning America" June 11, 1997http://www.planetarymysteries.com/energy/abc_tran.html . See also [Remediation of radioactive elements](#)

What we now need is more public awareness and support for the idea that neutralizing radioactive waste at the power plant may be feasible. In [Issues](#) I have suggested that even a highschool chemistry student could build an apparatus to demonstrate the basic principles. If our kids are doing it, then the universities and national labs will see their way clear to get this show on the road. Uncle Sam can tell them:



You don't need official permission from any governmental agency to demonstrate the basic principles of neutralizing radioactive waste that are described in the essay below. You just need enough courage to annoy a few authority mongers like those that were around a couple thousand years ago.

"And they said to Him, "By what authority are You doing these things?
And who gave You this authority to do these things?" --Mark 11:28, NKJ

My Equipment and Methods

First, I needed a Geiger counter, one that I could hook up to a computer The RM-60 Radiation Monitor from Aware Electronics (<http://www.aw-el.com/>) met my needs very well. It has a

Geiger-Mueller tube that has an alpha sensitivity of 2.5 MeV, 80% at 3.6 MeV, a beta sensitivity that is 35% at 50 KeV, 95% at 300 KeV, and a gamma & X-ray sensitivity of 10 KeV. The unit can be hooked up to a PC and the software handles the radiation counting. The files can also be converted to a Comma Separated Variables (.CSV) list and imported into an Excel spreadsheet for more extensive data analysis. The user manual was also very informative and a pleasure to read.

Second, I needed some radioactive waste to play with. It turns out the stuff is pretty hard to get ☺. But actually I wouldn't want it anyway. It is just too dangerous to have around. I needed something a lot safer. It turns out thorium will work quite well. So will uranium. Therefore I bought some thorium and uranium nitrates from a chemical laboratory supply house (no NRC license is needed for these items in small quantities). Thorium 232 ($^{90}\text{Th}^{232}$) has a half-life of 14 billion years. That is short enough to make a sensitive Geiger counter crackle vigorously, but long enough to be very safe for careful experiments, the main danger being inhalation of the dust. Uranium 238 ($^{92}\text{U}^{238}$) has a half-life of 4.5 billion years and uranium 235 ($^{92}\text{U}^{235}$) has a half-life of 0.7 billion years. The latter isotope represents less than 1% of natural uranium, but as you can see from the half-life, it is about six times more radioactive than the 238 isotope. Both isotopes are significantly more radioactive than thorium and would be useful in advanced experiments. All isotopes decay into "daughter products" which in turn are radioactive. The decay results in the "thorium decay series" and the "uranium decay series". Radioactive series eventually terminate in a stable, non-radioactive nuclide like an isotope of lead or bismuth.



These are the basic materials and tools required for these experiments. The yellow crystals in the plastic bag are uranium nitrate hexahydrate, but most experiments can be done with the safer thorium nitrate tetrahydrate. The RM-60 counter connects with a computer through the serial cable.

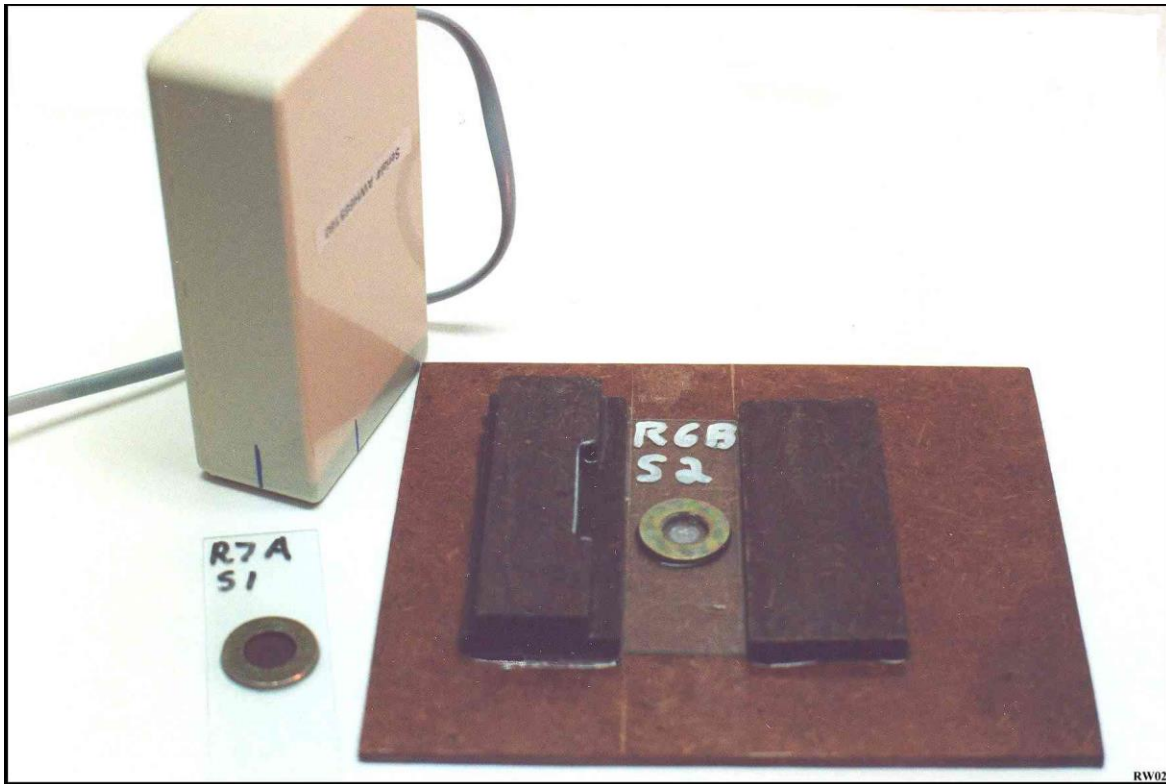
Third, I needed some fixtures to facilitate radiation counting. The fixtures would ensure uniformity and repeatability, which in this kind of research are extremely important. The bulk of the work in fact consists of hours and hours (or several days) of radiation counting. Running the reaction cell is only a minor part of the effort. Counts must be done both on electrodes as well as the liquid contents of the cell.

The scheme that seemed to work best for measuring the liquid portion was constructed from microscope slides that had an SAE 3/8 inch metal washer epoxied to them. The hole in the washer is slightly smaller in diameter than the aperture of the Geiger tube. I take the liquid I am going to process and make a set of "before" slides by putting 4 drops of the liquid into the hole in the washer and then fast evaporating it in an oven (about 200F). I repeat this until the hole has a total of 12 drops per slide (the hole will only hold 4 drops at a time). I usually do three slides as a set. Then I count each in the counting fixture in sequence, (slide #1, then #2, #3). Then I re-count each one until a total of three passes have been done on each slide. This gives me an idea of slide-to-slide sampling uniformity (about 6%) and measurement repeatability on any particular slide (about 2%)

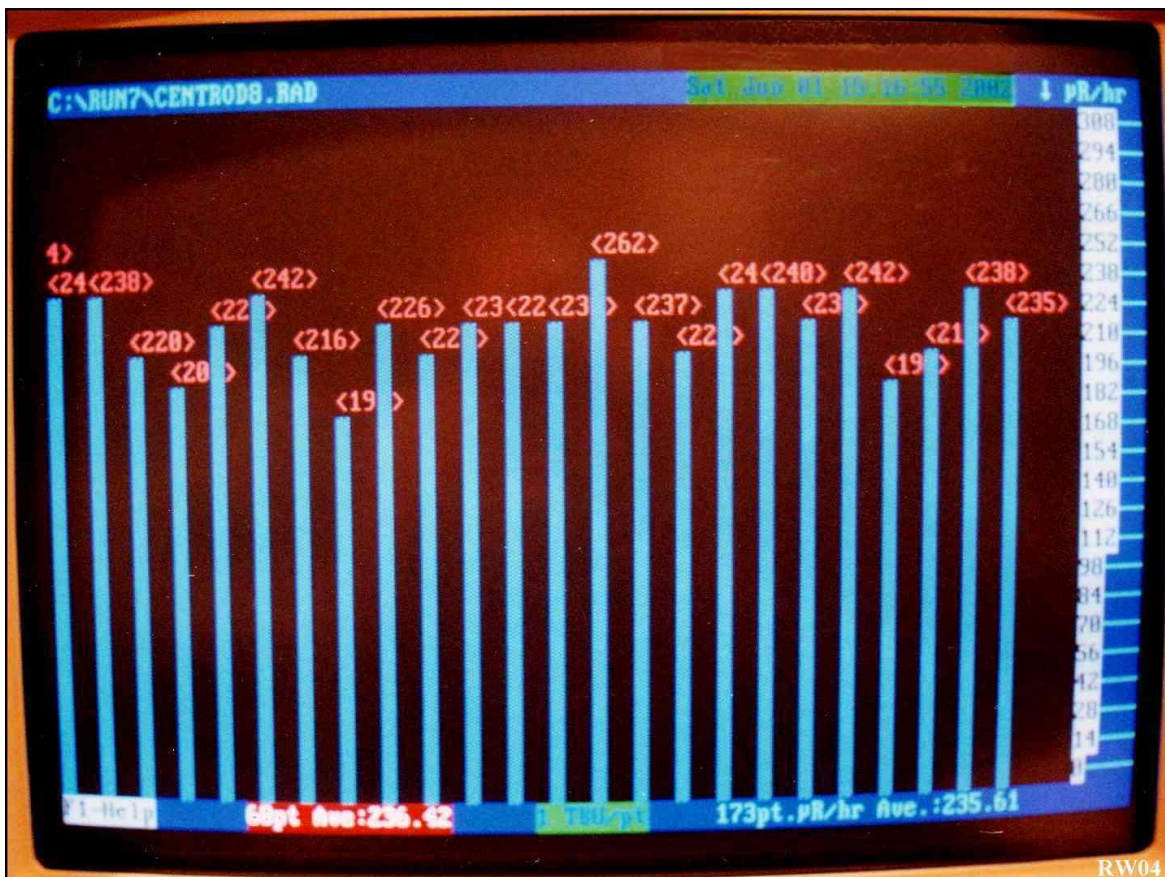
After the reaction cell is turned off, I make a similar set of "after" slides with the same technique. Electrolysis uses up a little bit of the water and some may have to be added to bring the cell back to the original dilution (less the 36 drops for the "before" samples) so that a valid comparison can be made. Also, the liquid may have a radioactive precipitate in it and so the liquid must be well stirred before taking samples.

The idea, of course, is to compare the before and after samples to see how the radioactivity has been affected by the electrolytic process. Both the intensity (counts above background level) and the shape of the decay curve are critical things to measure. You'll see some examples later.

After I am done "counting the slides" I cover the washer with a piece of cellophane tape, place the slide in a little plastic soap box (the kind used for travel) with the other slides, and store the box in a safe place. This is a precaution against contaminating my surroundings with radioactive dust.

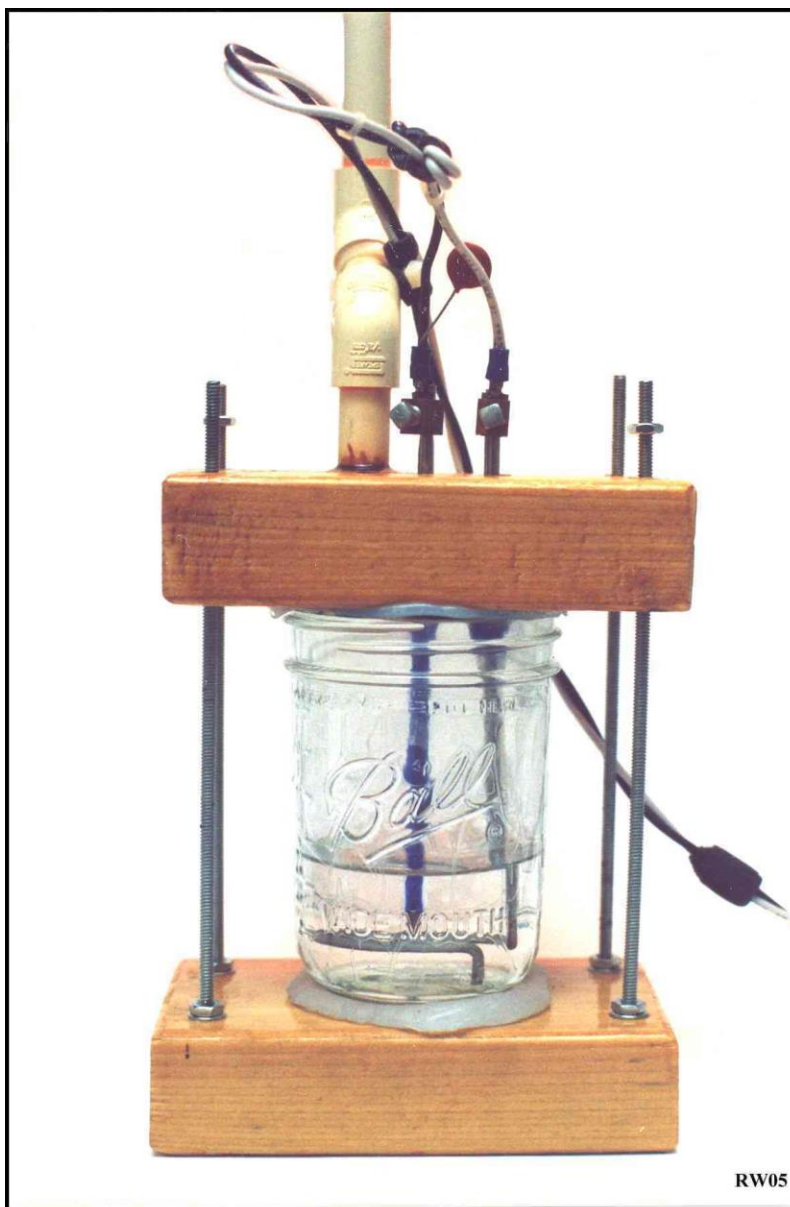


The slide counting fixture helps to position the geiger tube directly over the hole in the washer which contains the radioactive material. Slides are labeled with run number, whether they are before or after the run, and the slide number. Computer file names also include a measurement pass number (such as R6B-S2P1.RAD). No other slides or radioactive materials should be near the counter during a counting process. Unneeded slides are normally stored in a little plastic soap box and kept in a safe place away from the counter.

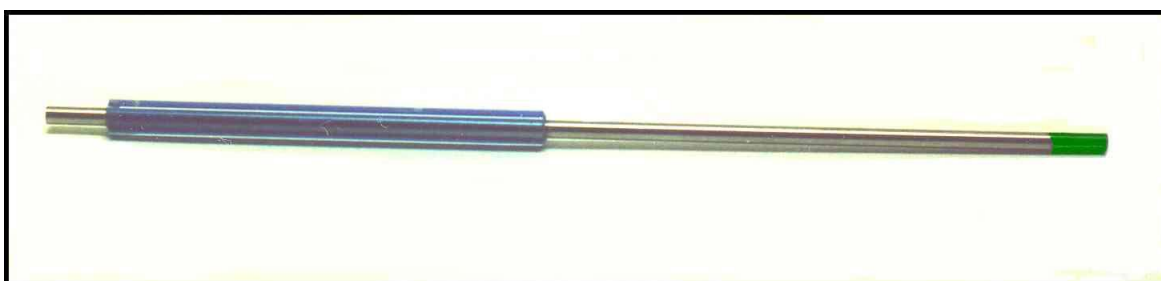


This is what the computer monitor looks like during counting (an electrode in this case). At the far right side of the screen, the blue bar shows that 235 counts have been received in one Time Base Unit (one minute in this case). The display scrolls leftward as counting continues (usually for days). Electrolyzed radioactive materials often show periodic variations in the bar graph display, as well as in the data plots.

Fourth, I needed an electrolytic reaction cell and a power source to run it. I designed the cell shown in the photo while I was walking around in a hardware store. It is basically an ordinary Ball wide-mouth canning jar mounted between two blocks of wood that have been coated with marine epoxy. Liberal amounts of silicon seal are used for cushioning or sealing. The electrodes are 1/8 inch diameter stainless steel rods, which each go through 3/16 inch stainless steel tubes. This allows the electrodes to be removed for counting, cleaning, safe storage, or using a different type of metal for the electrode such as tungsten. The cell is typically run with 1 gram of thorium nitrate tetrahydrate dissolved in 150 ml of distilled water. It may be electrolyzed with alternating current (AC) or direct current (DC). The threaded rods and nuts are part of a "positive control" scheme intended to keep this ungainly contraption in one piece when it is being moved around; this reduces the likelihood of inadvertently splashing hot, radioactive liquids or dropping the glass jar. The clamp nuts are removed before the cell is energized. Little sand bags (not shown) are placed on top to keep the lid sealed to the jar (the center area of the lid has been cut out with an electrolytic etch technique that uses salt water and a car battery charger).



This is my general-purpose electrolytic reaction cell. It has a provision for a reflux condenser that allows higher power levels to be investigated without boiling off the electrolyte. It is placed inside a 5 gallon plastic bucket before power connections are made.



This is a ground tungsten TIG welding electrode that has been partially sheathed in glass and silicon rubber sealant. It is made by injecting the glass tube half-full with sealant, closing off the full end with a finger, and pressing the electrode through it from the other end, causing the sealant to extrude around the electrode. The

green marking on the right end means that this electrode is pure tungsten. A red marking would mean 2% thoria alloy, yellow means 1% thoria, blue means 3%, brown means zirconia. Lanthanated and ceriated rods are also available. Tungsten does not corrode as easily as stainless steel. It is also useful in experiments requiring cathodes of high atomic weight.

Before a run, the cell is placed inside a 5 gallon plastic bucket and anchored with another sandbag at the base. The bucket is intended to confine glass shards if the cell explodes during operation (electrolysis will generate potentially explosive combinations of hydrogen and oxygen). The clear packaging tape around the jar will also help to reduce the mess. A hole in the lid allows the cell to be connected to an air-cooled reflux condenser, which is just a four foot piece of CPVC pipe. It is open to the atmosphere at the top end and merely condenses any steam generated by the cell during operation at higher power settings. The vinyl tubing, which connects the pipe to the cell, has some stainless steel scouring pad loosely strung through it to demist any vapors from the liquid boiling below it. There is also a small view port which is covered with plexiglass.



And yes, I run it in the bath tub (on top of a couple of car floor mats). I like having a wall and a door between me and something that could explode. The bathroom does not have pedestrians or inquisitive cats walking through it either. And the power comes from an outlet protected by a Ground Fault Interrupter (GFI) which should keep me from getting electrocuted if, in a moment of thoughtless inattention or complacency, I do something stupid.

The cell is powered by an old Superior Electric Powerstat. This is an autotransformer that can supply 0 to 140 volts AC at 15 amps (very overpowered for what I am doing). A small electric outlet box is wired so that a "load limiter" can be connected in series with the reaction cell. In this case the limiter is just a photo light bar with a couple of high wattage bulbs. In case of a bad electrical short, the lamps on the light bar will light up. This keeps the equipment from being damaged, the wall circuit breaker from popping open (and killing the computers on the same circuit), and me from becoming a nervous wreck. Another box contains a full-wave bridge rectifier in case I want to run the cell on DC. The cell power requirement at high voltage is estimated offhand to be 30-50 watts.

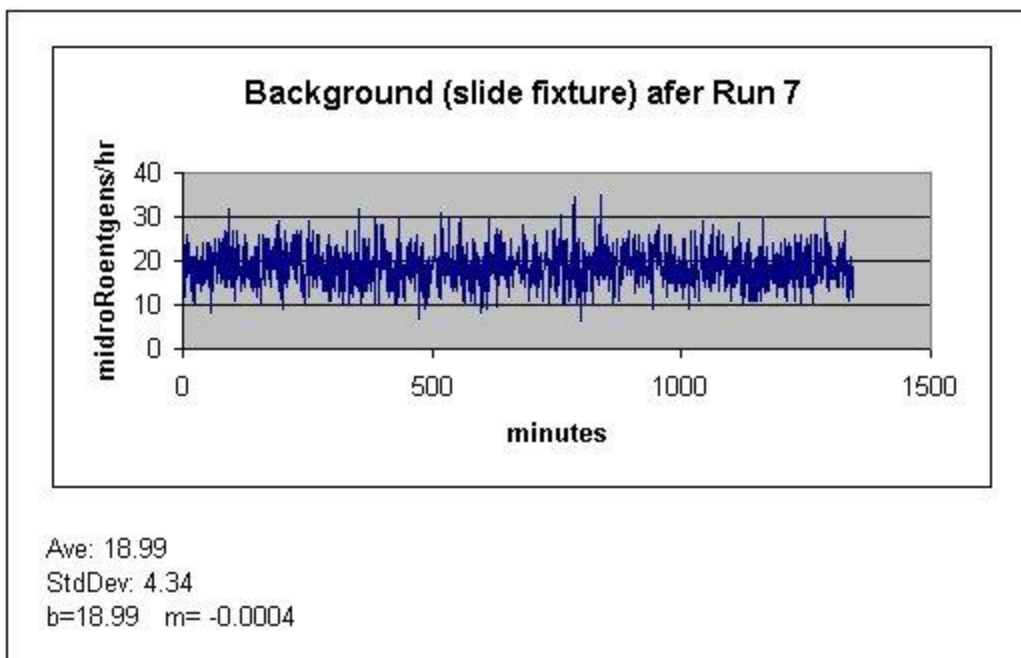
As you may deduce from all the above photos, the basic equipment shown is very primitive and built from spur-of-the-moment designs and junk box parts. It is nevertheless sufficient for proving that radioactive half-lives can be shortened from billions of years to a matter of hours by a quick and simple process.

Background Counting

For my nuclear physics amusement, I bought a 3 ounce container of Morton Salt Substitute from the grocery store and put it in front of the RM-60 counter. This salt *substitute* contains mostly potassium chloride instead of the usual sodium chloride. Potassium has a couple of stable isotopes that form the bulk of natural potassium: potassium 39 (93.26%) and potassium 41 (6.73 %). But there is also an unstable isotope, potassium 40, with a half-life of 1.25 billion years (more radioactive than uranium 238). Fortunately, it has an abundance level that is 0.0117 percent (one-hundredth of one percent) that of natural potassium. Nevertheless, its activity can be seen with a sensitive radiation counter. When I put the Morton Salt Substitute in front of the RM-60 counter, it registered about 30 microRoentgen/hr. Is this radioactivity enough to worry about?

To keep things in perspective, you need to know that the average background radiation in our everyday environment is about 5 to 25 microRoentgens/hr. It comes mostly from dirt, rocks, bricks, radon gas, and cosmic rays. Inside a jet at 30,000 feet the background might reach 300 microRoentgens/hr. Overall, the average American gets a cumulative radiation exposure equivalent to 10-20 chest X-rays per year. I measured the salt substitute inside a concrete building, where the background is about 19 microRoentgens/hr. The salt shaker therefore contributes only about 11 microRoentgens/hr above background. This is really not enough to worry about, not even if you have hundreds of these things in your coat, hundreds of them in your bed, thousands of them in your house. (and if you are *that* fond of salt substitute, you probably have *other* problems you need to worry about!). See also http://en.wikipedia.org/wiki/Banana_equivalent_dose .

The point, of course, is that we are continually bathed in a sea of very weak radiation. It unavoidably adds a "background" that must be taken into account when performing sensitive radiation measurements. I regularly take background readings on the fixtures that I use in my experiments, and then analyze the data in an Excel spreadsheet and plot it:



The count level, 19 microRoentgens/hr, from the fixture is essentially the same as that for the room in general. This shows that neither the RM-60 nor the counting fixture has been contaminated with stray radioactive dust. Note also that the curve is flat (albeit noisy); the background is essentially constant with the passage of time. We will later see that this observation is critically important for interpreting radiation measurements on materials that have been in the reaction cell.

My Early Experiments

First, I did a couple of shakedown runs to locate equipment problems and calibrate my level of nervousness. I used common baking soda (sodium bicarbonate) as the electrolyte.

The Powerstat gave me the most trouble. When I set the dial to zero and plugged it in, the circuit breaker at the main panel would pop open. I was left in the dark, and of course the computers crashed too (they were unavoidably on the same circuit). It popped the breaker in every outlet I tried, except for the particular *one* outlet that I used when I tested it originally! I got around the problem by adding a twenty foot extension cord and turning off a few lights. Later, during a run at higher power settings, the Powerstat would start sparking, hissing, and generating ozone. I had to take the thing apart, clean it up, and realign the rotor with the windings. After that it worked fine.

The load limiter, a simple light bar used for photography, had a little surprise too. It has a 500 watt bulb and a 300 watt bulb. During a run, the 300 watt bulb would start glowing first. I thought, "This is crazy. They are acting like they are connected in series." I had forgotten that years ago I had replaced the original on/off switch with an on/off/on DPDT switch, and I wired it for a series-start, parallel-run to extend the filament life. It was now in series and so I simply switched it to parallel.

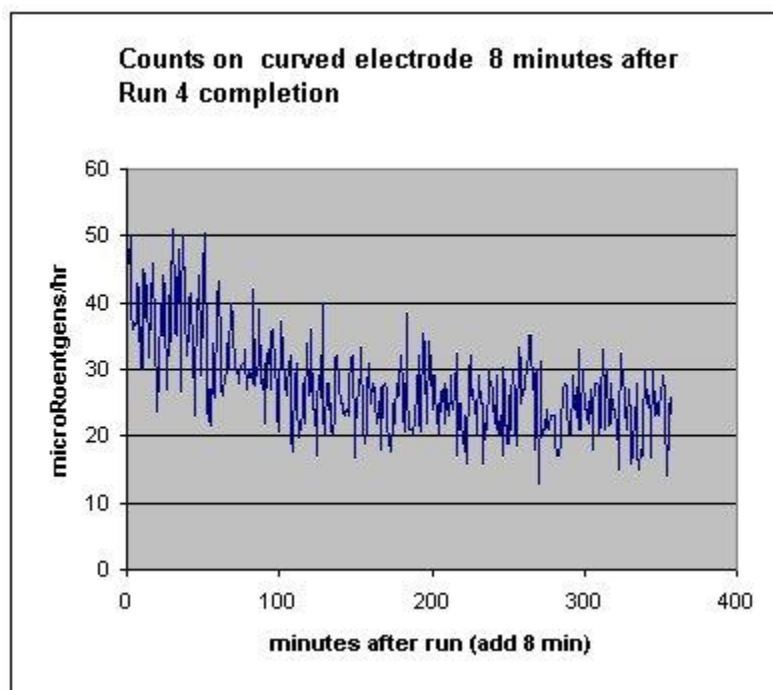
I also cranked up the voltage as high as it would go to see if the cell could be run in the incandescent electrode regime. I was barely able to get the center electrode to incandesce. It would emit little sparkles of yellow light (due to the sodium) and make a hash sound on the AM radio that I laid across the extension cord. (My *ad hoc* noise filter, consisting of a ceramic capacitor and a

couple of toroids was not very effective.) I was trying to avoid the incandescent mode for the first several runs, and so when I heard the hash unexpectedly, I turned down the power, but the noise did not stop. I traced the noise to a fluorescent light that had decided to go bad that day. Later, there was more noise, but this time it was apparently a motor in a vacuum cleaner. The power line was actually very noisy. I could not rely solely on the radio to detect incandescent mode (looking directly at a jar that has hydrogen, oxygen, and a sparking electrode is not my idea of a safe experience!)

Suffice it to say that practice runs can save you a lot of grief, especially if you are going to be using radioactive materials.

Finally, I did a run where I decided to collect data. The cell ran on thorium nitrate, alternating current, and stainless steel electrodes. After about a half hour, I took the cell apart. I noticed that the curved electrode had a thin layer of glittering, copper colored substance on it. Tiny metallic-looking whiskers were also visible. I decided to place the electrode in front of the counter and see what happened while the liquid portion cooled down.

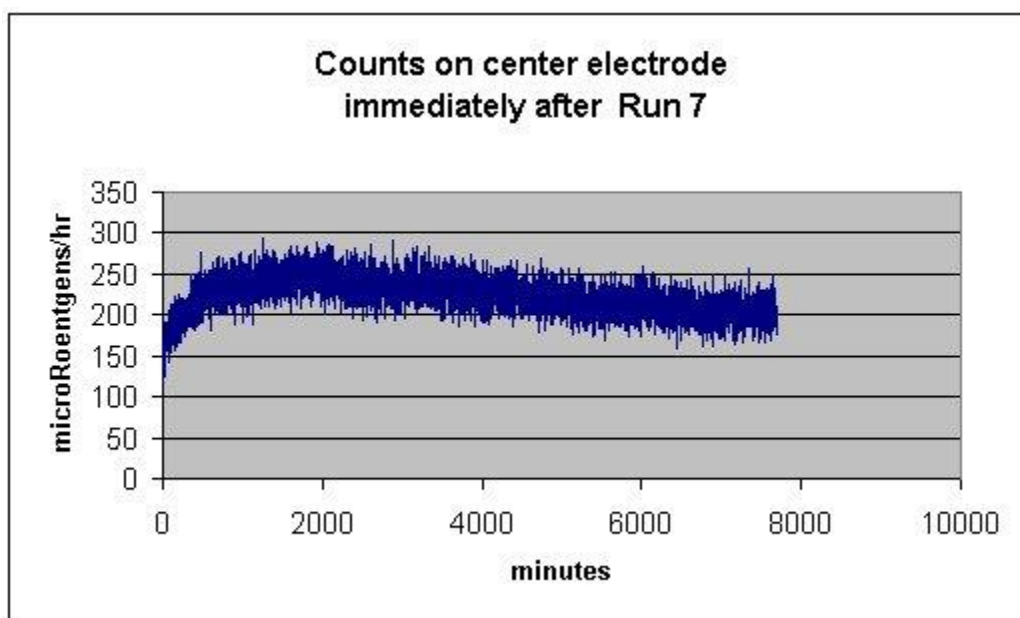
The counter showed that the dry electrode had significant radioactivity. With this realization, I began to feel kind of depressed. The cell was supposed to get rid of the radioactivity and it clearly had not accomplished that. I laid down for a few minutes to collect my thoughts. I woke up about two hours later. By then the counts per minute had decreased noticeably from about 40 to 30. I knew something significant had happened. Thorium has a half-life of 14 billion years, but now I was watching something decay in just a couple of hours! When I plotted the data, a discernable decay curve showed up:



The graph shows that the emission rate on the dry electrode starts out around 40 counts/minute (equivalent to 40 microRoentgens/hr on the RM-60) then seems to increase briefly, then decays in the pattern of an exponential curve (basically as expected), except that there seems to be some bursty, sawtooth effects as the emission rate approaches the background level (20 counts/min).

Although the radioactivity was not gone, it was clearly *going*, and it was not going to take billions of years either (the passage of 5 half-lives reduces the radiation by $1/25$ or to $1/32$ of the original; 10 half-lives would be less than one-thousandth).

Later I ran a cell that contained the brown sludge from the previous run. This was, in effect, my own "radioactive waste" and I just wanted to get rid of the stuff somehow. This time I used direct current along with stainless steel electrodes. The center electrode was the cathode. On runs with AC the center electrode acquired a shiny, electropolished look (industrial electropolishing is done with alternating current; see [below](#) for an important application). But this time the center electrode came out black. I decided to put it in front of the counter and see what happened. Here is the plotted data:



This one was even more of a surprise. The counting on the dry electrode began 8 minutes after the electrolysis was shut off. The emission rate starts out at about 150 counts/min and then steeply *increases* instead of decreases. It goes up to about 270 and then very slowly tapers off, again in somewhat of a sawtooth fashion. The counting was terminated after about 130 hours. After I plotted the data, I wished that I could have seen the first 8 minutes!

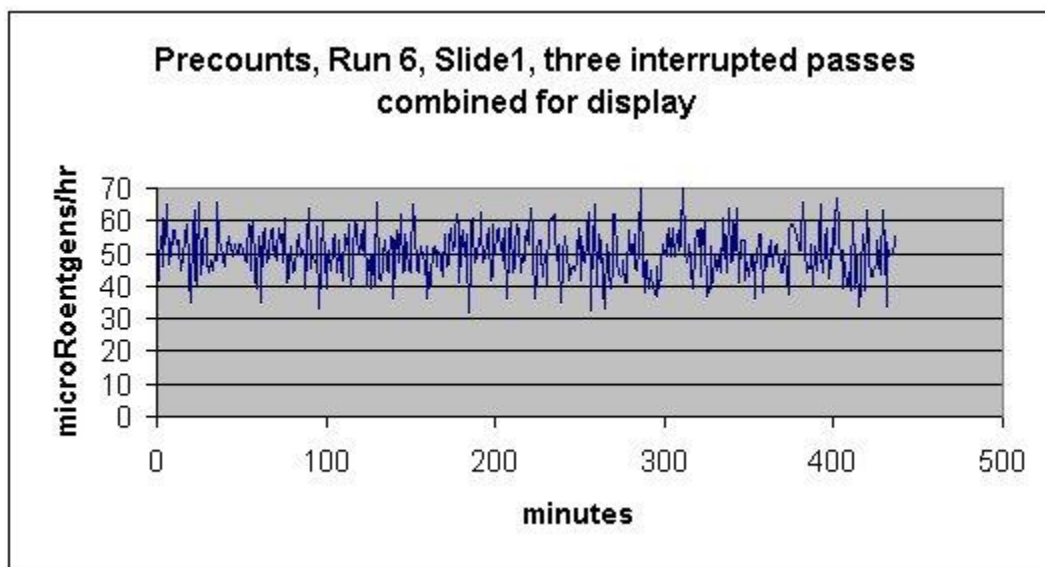
This leads to a working hypothesis that the electrolytic process converts thorium 232 to numerous daughter products. These are radioactive and are neutralized (in parallel) just like the thorium is, as long as the cell is operating. But when the cell is shut off, nothing neutralizes the existing daughter products. A complete radioactive "decay series" then emerges. The short-lived products cause the radiation to increase initially but after they "cook off", the longer-lived ones cause the decay curve to flatten out, although still trending downward.

The results seem to be very similar to those in an experiment by Goddard, Dash, and Frantz done with uranium. They used 10 mg samples and a 3 minute counting window with matched Geiger-Muller tubes:

"Previously, it has been reported that nuclear transmutation reactions are accelerated when radioactive elements are subjected to low-level electric fields during electrolysis of aqueous electrolytes. . . . Our research investigated the codeposition of U_3O_8 and H on Ni cathodes, using an acidic electrolyte and a Pt anode. Then, the radiation emitted by the electroplated U_3O_8 was compared with radiation emitted by unelectrolyzed U_3O_8 from the same batch. . . . The electroplated U_3O_8 initially produced ~2900 counts in 3 min (April 17, 2000). This rose sporadically in steps to 3700 counts in 3 min on May 11, 2000, and it remained relatively constant at this level until the . . . measurements ended on June 8, 2000. The unelectrolyzed U_3O_8 from the same batch emitted radiation at a much lower rate, ~1250 counts in 3 min, and this remained almost constant over the entire period of measurement." (G. Goddard, J. Dash and S. Frantz, "Characterization of Uranium Codeposited with Hydrogen on Nickel Cathodes", *Transactions of the American Nuclear Society*, **83**, 376-378 (2000)).

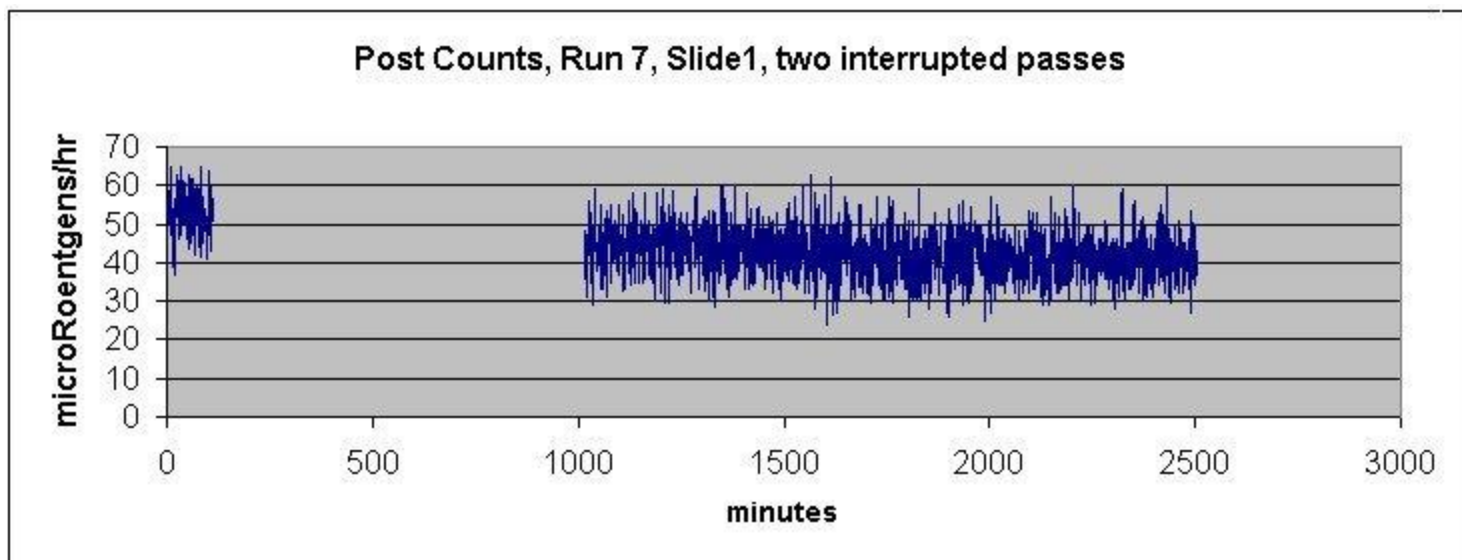
Later they did gamma ray measurements and these showed that, overall, the electrolyzed sample was 1.7 times more gamma emissive than the unelectrolyzed sample.

Of course I still wanted to know what was happening with the copper-colored sludge. The precount slides on unprocessed thorium nitrate tetrahydrate typically show the following pattern:



Note that the counts are around 50 and that the trend of the plot is flat. This is exactly what you would expect. Something that has a half-life of 14 billion years is not going to show a noticeable change in decay rate in several hours. There is no obvious sawtooth pattern either; I had worried that the cycling of the air conditioner could somehow show up on the graphs.

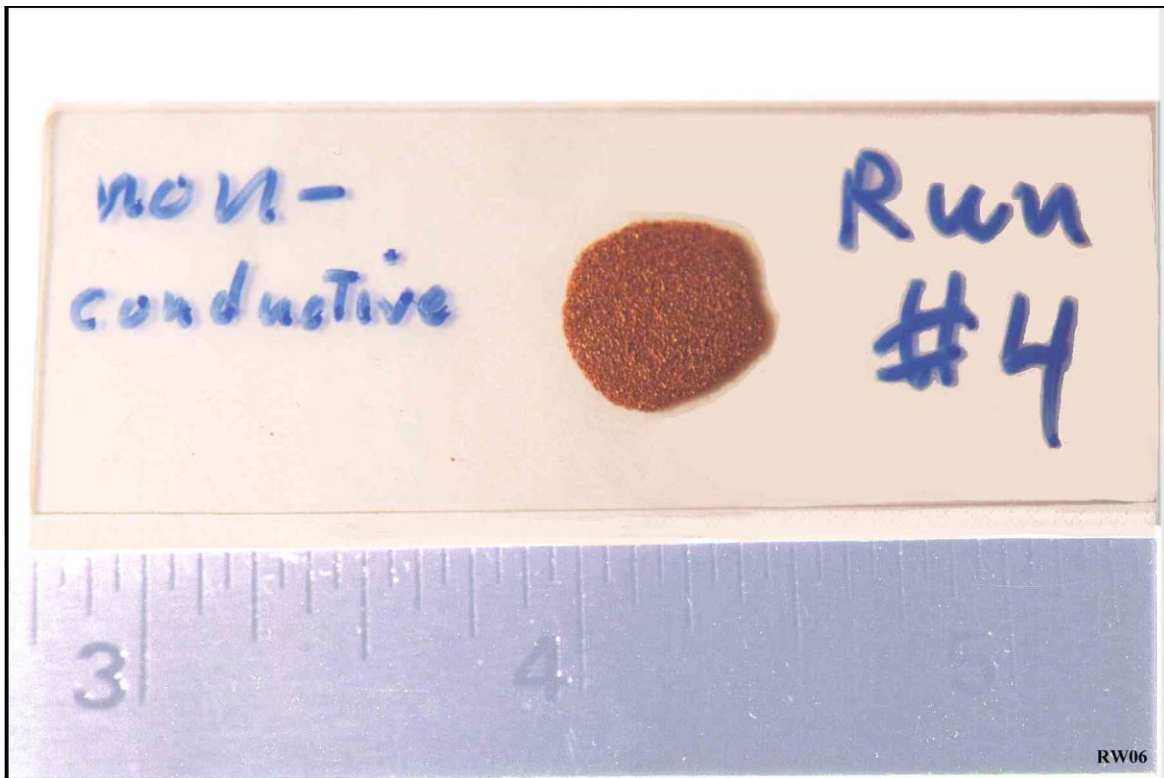
Post counts on the dried copper-colored sludge slide looked like the following:



Here the radioactivity starts out between 50-60 counts/minute (higher than the original 50) but after 1000 minutes has decayed to between 50-40, and at 2500 minutes has decreased to about 40. (During the blank range I was counting a different slide.) A week later the average had dropped to 38. There is still quite a bit of radioactivity present, and it is not decaying as fast as desired. Clearly though, it *was* affected by the electrolytic process, and in a manner similar to the electrode.

After the run with AC and stainless steel electrodes, the liquid looked something like iced tea with copper paint stirred into it. The liquid had tiny, iridescent particles that looked like metal flecks of copper (the same stuff that I saw on the electrodes). They were fascinating to watch as they were slowly swept around in the thermal currents of the slowly cooling liquid. Copper is a transmutation product that has been seen in these kinds of cells. But I had my doubts that this was copper. There was an awful lot of it. If it got there by transmutation, its presence would represent the release of a lot of energy, but none was apparent. Did it all go off as neutrinos (which do not interact with the environment and produce heat)? Very unlikely. And I could *see* the particles. That meant they must be at least 40 microns in diameter (the limit of unaided vision), and if they were that big and made of metal, they should be settling out of the liquid a lot faster.

After several hours, the particles had settled out and I removed the "supernatant liquor" with a modified turkey baster. I scooped out a sample of the sludge and dried it on a microscope slide. It looked just like a blob of fine, glittery copper particles:



But it was non-conductive. It could not be copper. (I really don't know what it is. My best guess would be a mixture of thorium and ferric hydroxides, the latter coming from corroded stainless steel electrodes).

"Wherever the tree falls, there it lies." —Ecclesiastes 11:3

Tempted to try it yourself?

Students might ask "Can I do this experiment as part of a highschool science project?" And teachers might view it as a possible project in an honors program. So I am sure such questions will come up. Here are some things to consider.

Remember that one of my purposes here is to show that radioactive decay rates can be affected by a simple electrolytic process, and that this suggests a way of neutralizing radioactive waste that should be promptly and vigorously investigated. I am really not so much interested in students doing these experiments as I am in having parents realize "If my kid can do it, why can't the Department of Energy do it? Why should I have tens of thousands of tons of radioactive waste being shipped through my state? Why should we spend \$57 billion on STORAGE of radioactive waste if there might be a way to neutralize it right at the power plant?" ([Advertisement2.pps](#) ; press ESC to exit) As I have explained above, the obstacles to this research are more social and political than technical. The popular press has convinced people, through irresponsible journalism, that this is "junk science". Consequently, universities won't touch it for fear of public criticism and loss of prestige and funding. The government isn't going to listen until they hear that mom and dad are convinced that this kind of research is worthwhile. (see also [military interested](#))

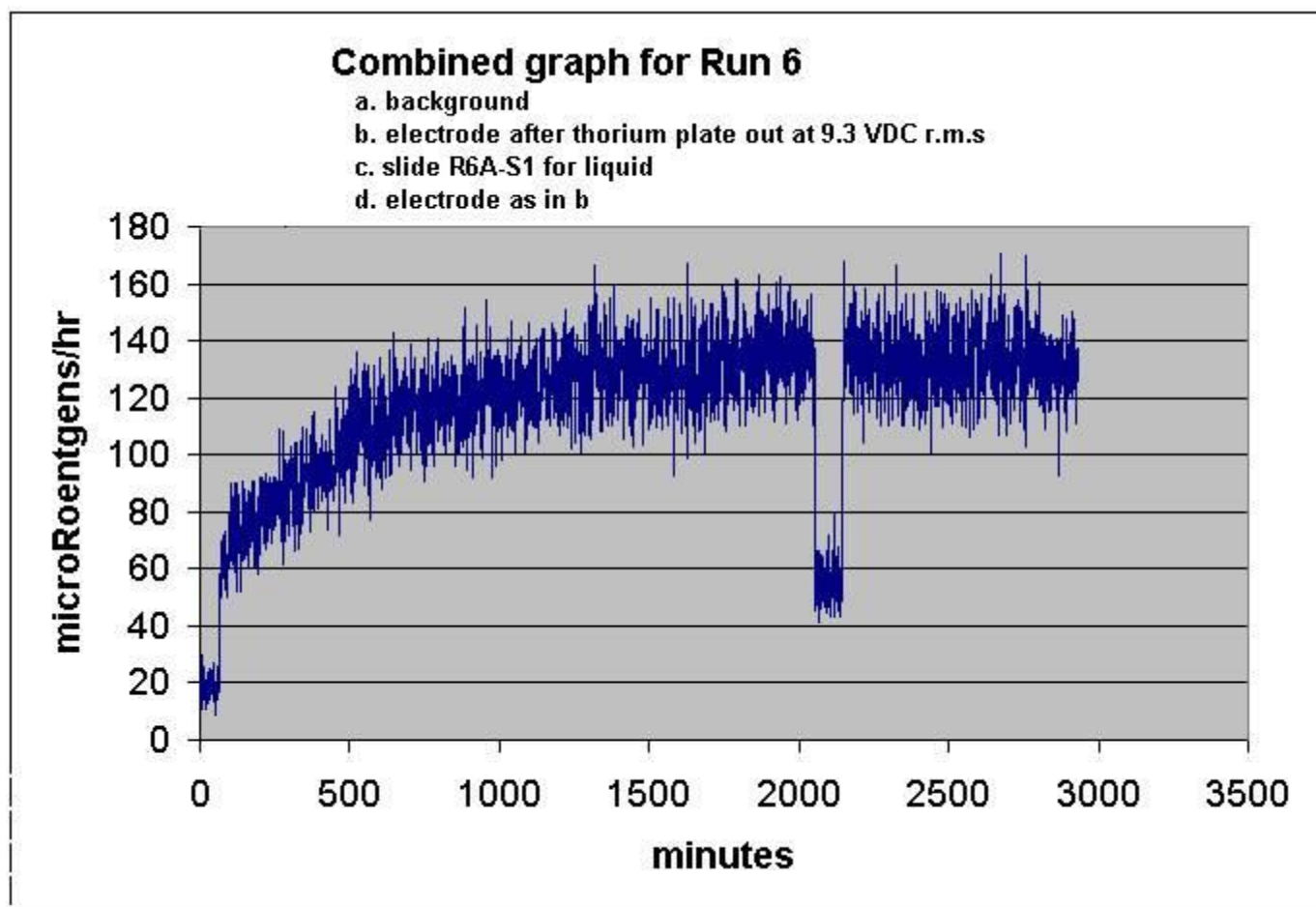
Nevertheless, if you decide to try this experiment as a science project, you will of course need adult sponsorship* and professional supervision from your teacher. Your teacher will probably have several suggestions. One will undoubtedly be to use only hardware that is specific to the purpose of the experiment. The equipment in the illustrations is intended for multiple purposes and can be simplified *if you copy the essential principles, not the equipment*. For instance, you can use a nine volt battery for the power supply. This is strongly recommended and will greatly improve safety and reduce equipment complexity. You should also use much less thorium nitrate. If you want to use AC, use a doorbell transformer or one of those little plug-in transformers (the AC type) and give careful attention to electrical safety (including shields, fusing, grounding, GFI protection, and power ratings). You'll need well-shielded and physically stable counting fixtures, and some rudimentary skills with data analysis software like Microsoft Excel. Your teacher might arrange to have operating cells and counters in a locked display cabinet, and might want to handle all radioactive material himself, instead of letting a student do it. Remember that teachers always want to know "What are you going to learn from doing this?" Be prepared with a list of answers (review relevant material in [Issues](#)). And finally, PUBLISH YOUR FINDINGS on the Internet (please send me a link) and explain why they are important. (*in many states it is probably unlawful for people less than 18 to work on radioactive materials. Check your state laws and proceed appropriately)

Also, expect a little hysteria when proposing experiments of this type. Parents and teachers are not generally aware that our environment contains radioactive materials like thoriated mantles in the gas lamps that might light your street, thoriated tungsten rods that are used in welding, monazite sand sometimes used in pottery, the tiny amounts of americium in smoke detectors (don't mess with it!), the potassium 40 circulating in your own body, and the equivalent of the 10-20 chest X-rays Americans get every year from ambient radiation. When a clerk at the photo shop saw the photo with the cans of thorium and uranium nitrate (above), I ended up having a little unscheduled talk with the police after I drove home from church. The labels visible in the photos had words like "nitrate", "radioactive", "may cause cancer", "Oxidizer. May cause fires", and so forth. They did not understand the rest of the photos either, and just wanted to know what I was doing. The next day (Monday), there was a lot of publicity about the arrest of a suspect in a radiological bomb ("dirty bomb") plot. I was actually glad that the police had already talked to me.

When people have questions and concerns, try to deal with them as God deals with Christians: "If any of you lacks wisdom, let him ask of God, who gives to all men generously *and without reproach* . . ." (James 1:5). And some words of advice from a guy in government, namely, King Solomon: "He who keeps a royal command experiences no trouble, for a wise heart knows the proper time and procedure" and "If a ruler's temper rises against you, do not abandon your position, because composure allays great offenses." (Ecclesiastes 8:5 and 10:4). "By forbearance a ruler may be persuaded, And a soft tongue breaks the bone." (Proverbs 25:15) Keep a cool, patient head, and maybe those around you will too.

And remember . . . It's an *adventure*! Be careful, but enjoy the wonder!

Low Voltage Electrolysis



A different method was used to collect data for Run 6. The counter was started as a background counter and then the dry electrode was placed in the electrode counting fixture directly after the run and while the counter was already operating. The delay to get data was only 2 minutes instead of the usual 8. As expected, the electrode radioactivity increases with time. Later, the RM-60 was moved from the electrode fixture to the slide fixture. Counts on the dried liquid sample imply that quite a bit of the thorium did not plate out and is still in the liquid. The RM-60 was then transferred back to the electrode counting fixture. This scheme helps to reduce any effects of geiger tube warm up or software initialization.

Things to keep in mind

Please keep the following in mind when designing experiments or reviewing those presented above:

1. Before meaningful measurements can be made on electrodes or on a liquid, the electrolysis must be stopped. This is because electrolysis will move the radioactive ions around and change their geometrical relationship with the counter. The radioactive ions may plate out on the cathode, or they may precipitate out of the solution and settle to the bottom of the container. Or bubbles may sweep them to the top and they may stick to the sides like a bathtub ring. If you have the counter looking at an operating reaction cell, you may see a decrease (or increase) in the measured radioactivity, but this may be due to radioactive ions moving to a different location, not because there has been any basic change in radioactivity levels. In fact, this can happen even if the cell is

not energized; uranium can self-plate onto an electrode just like copper will self-plate onto an iron nail in a solution of copper sulfate.

2. The geometrical relationship between the counter and the dry electrode (or dry sample) must be fixed and stable. If the counter is looking at a portion of an electrode and then gets bumped, or moved by a wife who wants to "tidy things up a bit", then the results are going to be skewed, and may lead to an unsupportable conclusion. This is why counting fixtures are so important.

3. Total amounts of radiation are NOT measured in these experiments. Instead, the radioactivity of an essentially unknown (but fixed) amount of electrolyzed material is compared with the radioactivity of an unknown amount of *un*-electrolyzed material. *Only the behavior with time* (the *shape* of the decay curve) has any meaning in this setup, not the absolute level of counts. In the experiments shown above, the decay curves of electrolyzed material that satisfied the above two requirements showed either a fast *decrease* in radioactivity, or a gradual *increase* in radioactivity. Virgin, un-electrolyzed material just showed a flat line with essentially constant radioactivity levels. (Amounts are chosen only to give a signal that is significantly above the background level.)

4. Radiation measurements that are done on a liquid with the counter viewing the liquid through the wall of a plastic container will register only beta and gamma counts, with no alpha counts (alpha particles are easily stopped by the water and the plastic). In contrast, measurements on bare, dry material will also register alpha counts besides the beta and gamma counts. (If you run measurements on a liquid, it is a good idea to remove the electrodes, so that there is no possibility of radioactive metal deplating from the electrodes and re-entering the liquid phase.)

Thorium and uranium are used in these experiments for safety reasons, not because people care about neutralizing the radioactivity of these very long-lived isotopes. Similarly, very short-lived isotopes are not of much concern either; the radioactivity from these materials is intense, but burns off to safe levels in just a few days, weeks, or months. The real concern is with the isotopes that have intermediate half-lives of dozens of years to tens of thousands of years. From the human standpoint, these are both intensely radioactive, and intensely persistent. Cesium 137 has a half-life of 30 years; strontium 90, 29 years; radium 226, about 1620 years; plutonium 239 and 240, about 24,000 and 6,537 years respectively. The passage of 20 half-life periods will decrease the radioactivity levels by more than a million. But you can readily see that tens of thousands of *tons* of this stuff is going to remain dangerously radioactive for a long, long time. That is why any simple economical process that affects radioactive half-lives is of great significance. No one will care if you can change the half-life of thorium from 14 billion years to a few days, but if you could change the half-life of strontium 90 from 29 years down to a month or a week, that would have enormous scientific and economic implications. Currently, we do not know if isotopes with intermediate half-lives are more sensitive to electrolytic neutralization than long-lived isotopes. And unfortunately, experiments on these intermediate materials are far too dangerous for the amateur experimenter.

However, see:

"Radioactive half-life experiment, barium-137m" (Thomas Jefferson National Accelerator Facility)

http://education.jlab.org/frost/halflife_part1.html

http://education.jlab.org/frost/halflife_part2.html

http://education.jlab.org/frost/halflife_part3.html

[United Nuclear Scientific Equipment and Supplies](#)

And here is an account about the use of high temperature and electric fields in neutralizing a sample of radioactive Cobalt 60:

Can I do the same operation with the equipment for a gamma radiating cobalt specimen and get a similar result? A time was agreed to and with Cecil's directions and under his watchful eye I operated the equipment to try to obtain a similar result. A specimen that had a high active count was selected for the test. Equipment was checked for radioactivity and indicated background levels. The specimen was placed on the pedestal, arc gap adjusted, bell jar was greased and placed on its platform. Electrical connections were checked for the correct polarity, i.e., a negative charge (positive charge for all you electrical engineers) on the pedestal where the specimen was placed. Electrical equipment was switched on for the vacuum pump and for the electric controls to the specimen.

The vacuum pump had to create a reduced pressure in the bell jar for the purpose of creating an electrical arc (3000 volts maximum from the center tap transformer) and thus the heating effect on the specimen once the electrical arc was established and at the same time placing a negative electric field (less than 3000 volts when operating with the electrical arc) on the specimen for deactivation that was placed on the pedestal in the evacuated bell jar. The major concern was obtaining an adequate temperature (critical deactivation temperature) on the specimen by the electric current in the vacuum and power available from the electrical equipment, since it was limited by available electrical power current. The specimen attained a nice orange glow, probably somewhere around 2400 degrees Fahrenheit. Held at temperature for a minute or so and turned off the vacuum pump. The electric arc was then broken as the bell jar lost its vacuum. The heating stopped since the electrical arc was broken. The electrical field was maintained during cool down of the specimen. The electric field was discontinued after the specimen had cooled down and the bell jar was removed.

The Geiger Counter was then used to make radiation measurements. The specimen showed background readings. The result was very few counts as compared to the high number of counts prior to treatment. The pedestal, bell jar, HEPA filter located between the bell jar and the vacuum pump, vacuum hose, and the vacuum pump were still at their initial background readings. The data convinced me that elimination of radioactivity and deactivation/neutralization had occurred for the treated cobalt specimen. "Radioactivity Deactivation at High Temperature in an Applied DC Voltage Field Demonstrated in 1964". Larry Geer & Cecil

Baumgartner, http://www.gdr.org/nuclear_half.htm

Update 10-30-16: Another comprehensive source of information and patents pertaining to radioactivity reduction is at <http://www.rexresearch.com/fukushimamour/fukushima.htm> This is an excellent link; be sure to visit it (the implications are very disturbing).

"Mining" of high-level radioactive waste

It is well known that the fission process produces many other elements, some of which are quite valuable. Removal of the radioactivity in the "spent fuel" makes these newly created elements more accessible:

"When nuclear fuel is irradiated in a power reactor a wide range of chemical elements is created by the fission of uranium and plutonium. These fission products include palladium, rhodium and ruthenium, and could in principle constitute a valuable source of these three metals. "Recovery of Platinum Group Metals from High Level Radioactive Waste", R. P. Bush, *Platinum Metals Rev.*, 1991, 35, (4); <http://www.platinummetalsreview.com/pdf/pmr-v35-i4-202-208.pdf> ; See also: http://en.wikipedia.org/wiki/Synthesis_of_precious_metals ; <http://pubs.acs.org/doi/abs/10.1021/ie900265y> ; <http://www.wmsym.org/archives/2001/55/55-4.pdf>

Additionally, the neutralization process itself produces still other elements, and apparently the various processes can be adjusted to favor particular nuclides. The tens of thousands of tons of high level radioactive waste could become a valuable resource instead of a deadly environmental hazard.

Links:

<http://scripturalphysics.org/qm/issues.html#CincinnatiGroup>
<http://scripturalphysics.org/qm/issues.html#ExampleElectrolyticCFP>

An Afterthought: *Extending* radioactive half-lives might also be useful

The focus of the above article has been on *reducing* the half-lives of radioactive materials, especially nuclear waste, in order to render it safe for disposal. However, an opposite kind of technology might also be possible: a technology to *extend* the half-lives of radioisotopes.

There are three reasons this should be investigated:

1. Extending the shelf life of valuable medical radioisotopes might be possible. Technetium 99m is widely used in nuclear medicine for "functional" diagnostic medical imaging. It has a half-life of 6 hours. This is long enough for functional studies, but short enough so that the residual radioactivity is not a nuisance (people in an airliner don't like sitting next to a slightly radioactive former patient). Because of the short half-life, the Tc-99m has to be produced just before use, usually offsite in a molybdenum 99 generator. The Tc-99m, of course, decays during transport to

the hospital. Costs would go down and convenience improved if such isotopes could be prepared, purified, and preserved in a special environment that makes such radioisotopes stable.

2. Studies of elements at the upper end of the Periodic Table might be possible. Elements at the upper (heavy) end of the Table from about polonium, element #84, to the unnamed element #118, show generally increasing instability. They either eject mass in the form of alpha particles, or simply split in two (fission). The ability to create and preserve such elements indefinitely would greatly facilitate studies of these heavy elements.

3. Demonstrating that half-lives can be altered artificially has deep geochronological and cosmological implications. Suppose the Earth at one time had all the elements of the Periodic Table and that they were all stable (non-radioactive). Then suppose some process occurred on a time span of millions of years, and with increasing intensity, that caused the heavier elements to become radioactive. Elements at the upper end of the Periodic Table would begin disappearing. Perhaps several thousand years ago this process began to affect polonium, which until that time was a stable element. This could explain the mystery of "parentless" polonium radiohalos such as those in Gentry's careful studies that have been used to support the "instant Earth hypothesis" advanced by Creationists. Some references:

http://www.pathlights.com/ce_encyclopedia/04earth4.htm

A Brief Summary of Gentry's Findings

Pathlights, PO Box 300, Altamont, TN 37301

<http://personal.bgsu.edu/~roberth/gentry.html>

Gentry's Radiohalos

<http://www.grisda.org/origins/15032.htm>

Examining Radiohalos, R. H. Brown, H. G. Coffin, L. J. Gibson, A. A. Roth, and C. L. Webster, Geoscience Research Institute, *Origins* 15(1):32-38 (1988), Literature Review: Creation's Tiny Mystery, R. V. Gentry. 2nd ed. (1988). Earth Science Associates, Knoxville, Tennessee. 347 pages.

<http://www.leaderu.com/real/ri9403/date.html>

The Creation Date Controversy, Dr. Hugh Ross, Ph.D.

<http://creation.com/age-of-the-earth>

"101 evidences for a young age of the earth and the universe"

<http://creation.com/diamonds-a-creationists-best-friend>, "Diamonds: a creationist's best friend, Radiocarbon in diamonds: enemy of billions of years", by Jonathan Sarfati

Also, (in case you are wondering) the Bible says: "In the beginning God created the heavens and the earth." (Genesis 1:1). The time is indefinite and could easily have been millions of years or longer for the creation of the *physical* heavens and earth. The preparation of the (already existing) earth for habitation took six Creative Days. God rested on the seventh Day, but there is no

scriptural statement that the seventh Day ever ended. On the contrary, it seems to have continued down to our time (Hebrews 4:3-6, 9), and this implies that a Creative Day is at least 6000 years long.

And while we are at it, please note that the earth was worked over by water on *two* occasions, not one. The first was the waters of Creation, (Genesis 1:2) which probably converted the surface of the earth from a pile of rocks (like those evident on Mars and Venus) into something that was more like fine dirt. The other was the Flood of Noah's day (Genesis 7 & 8).) Both events need to be taken into account when trying to determine the ages of rock strata.

See [Advanced Atomic Energy Converters](#) and [Some Thought Provoking Issues](#) for some thoughts on how neutrinos might be involved somehow in long term elemental instabilities.

Natural radioactive decay rates might not be constant. In fact, we have studied radioactive decay on earth for only about 100 years, and still do not understand what actually causes radioactivity. Isotope geochronology (ages of rocks, planets, stars, etc.) is based on this limited knowledge and extrapolates it out to *billions* of years and applies it to things that are far outside of our experience. If I did something like that, I would be accused of promoting "junk science"! (See also/[4v4a/ADVPWR.html#ExcessMass](#) ; [qmconcept.htm#SpinOrbitCoupling](#))

"But the way of the wicked is like deep darkness;
they do not know what makes them stumble."

Proverbs 4:19 NIV

Update 11-27-08: Researchers believe they have seen variations in the radioactive decay rates of silicon 32, chlorine 36, manganese 54, radium 226, and possibly plutonium 238. The variations are typically a few tenths of one percent and seem to correlate with the yearly variations in Earth-Sun distance. The scattered quotes below are from "Half-Life (more or less)", by Davide Castelvecchi, Science News, Nov 22, 2008, p. 20-23:

" . . . when researchers suggested in August that the sun causes variations in the decay rates of isotopes of silicon, chlorine, radium, and manganese, the physics community reacted with curiosity, but mostly with skepticism."

"Both experiments had lasted several years, and both had seen seasonal variations of a few tenths of a percent in the decay rates of the respective isotopes."

"In those experiments, the decay rate changes may have been related to Earth's orbit around the sun, the Purdue teams says. In the Northern Hemisphere, Earth is closer to the sun in the winter than in the summer. So the sun may have been affecting the rate of decay, possibly through some physical mechanism that had never before been observed."

"The closer to the sun, the denser the shower of neutrinos."

"If the results are confirmed, and nuclear decay is not immutable, perhaps physicists could find a way to speed it up to help get rid of waste from nuclear power plants."

"About 7 percent fewer solar neutrinos hit detectors when Earth is furthest from the sun, compared with when it's closest, says Arthur B. McDonald, director of the Sudbury Neutrino Observatory in Ontario." Science News, Vol 160, No. 8, August 25, 2001, p. 115

See "Evidence for Correlations Between Nuclear Decay Rates and Earth-Sun Distance", J. H. Jenkins, *et al.* Available online at <http://arxiv.org/abs/0808.3283> ; "The strange case of solar flares and radioactive elements", Stanford University, <http://www.sciencecentric.com/news/10082629-the-strange-case-solar-flares-radioactive-elements.html>

"Is the Sun emitting a mystery particle?", Ian O'Neill, 2010, <http://news.discovery.com/space/is-the-sun-emitting-a-mystery-particle.html> :

However, when they compared their measurements with other scientists' work, the values of the published decay rates were not the same. In fact, after further research they found that not only were they not constant, but they'd vary with the seasons. Decay rates would slightly decrease during the summer and increase during the winter.

As the Earth is closer to the sun during the winter months in the Northern Hemisphere (our planet's orbit is slightly eccentric, or elongated), could the sun be influencing decay rates?

In another moment of weirdness, Purdue nuclear engineer Jere Jenkins noticed an inexplicable drop in the decay rate of manganese-54 when he was testing it one night in 2006. It so happened that this drop occurred just over a day before a large flare erupted on the sun. . . .

The sun link was made even stronger when Peter Sturrock, Stanford professor emeritus of applied physics, suggested that the Purdue scientists look for other recurring patterns in decay rates. As an expert of the inner workings of the sun, Sturrock had a hunch that solar neutrinos might hold the key to this mystery.

Sure enough, the researchers noticed the decay rates vary repeatedly every 33 days -- a period of time that matches the rotational period of the core of the sun. The solar core is the source of solar neutrinos.

It may all sound rather circumstantial, but these threads of evidence appear to lead to a common source of the radioactive decay rate variation. But there's a huge problem with speculation that solar neutrinos could impact decay rates on Earth: *neutrinos aren't supposed to work like that.*

"'Scientists don't know why': Cesium-137 in soil near Chernobyl has half-life of 180 to 320 years, not 30 years as is typical", <http://enenews.com/scientists-don%e2%80%99t-know-why-cesium-137-in-soil-near-chernobyl...> ; <http://www.wired.com/wiredscience/2009/12/chernobyl-soil/>

"Radiometric Dating: Is the 'Decay Constant' Constant?", Anderson, John Lynde & George W. Spangler (1974), *Pensée*, No. 4 (Fall 1974), 31-33.

"Serial statistics: Is radioactive decay random?", Anderson, J.L. and G.W. Spangler, 1973, *Phys. Chem. J.*, 77 (26) : pp. 3114 - 3121.

"Fine structure of histograms of alpha-activity measurements depends on direction of alpha particles flow and the Earth rotation: experiments with collimators", Simon E. Shnoll, Konstantin I. Zenchenko, Iosias I. Berulis, Natalia V. Udaltsova, Ilia A. Rubinstein, submitted 1 Dec 2004, <http://arxiv.org/abs/physics/0412007>

If "solar neutrinos impact decay rates on Earth", this should not be hard to investigate with spacecraft. Equip interplanetary space probes with matched radioactive samples and matched radioactivity detectors (appropriately shielded from everything except neutrinos). Send one to Mercury and another to Mars (or where-ever). There will be a big difference in solar neutrino flux at different distances from the Sun, and therefore a change in decay rates should be easily detected and easy to predict.

Note 12-9-09: One might want to consider an astrophysical implication of the neutrino/atomic decay hypothesis. As dust particles in outer space are pulled into the Sun by its gravitation, the nuclides comprising them are subject to an evermore intense flux of neutrinos. This will cause some previously stable elements to become radioactive, and some already unstable nuclides to become even more radioactive. Once they are actually inside the Sun and have mixed with the solar material for a long time, they will presumably reach a new neutrino/atomic decay equilibrium relationship and become stable. After a very long time, the star will finally enter the supernova stage and blow itself to bits. This drastically changes the density of its matter, and the previously existing neutrino flux drops drastically in intensity too. This *again* upsets the neutrino/atomic decay equilibrium and may cause previously stable nuclides to *again* become radioactive. Supernova products like nickel 56 and cobalt 56, which have half-lives of 6.1 days and 77 days, respectively, may be the result of such a process.

Fluctuations in neutrino flux could affect the decay rates of radionuclides in the Earth. These are very dilute, but scattered throughout a body the size of a planet, and neutrinos can easily pass through an entire planet. The consequent fluctuations in radioactivity could cause the Earth to internally heat up (or cool down) slightly. Whether this has any implications for "global warming" or other geologic changes is not clear, but it is a loose end that should be given some expert consideration.

Update 6-29-11:

"Radioactive isotope decay rate or half-life can be increased or decreased as needed to deactivate radioactivity or to increase shelf life of radioactive isotopes. Currently many investigators/experimenters have reported half-life anomalies and have demonstrated repeatability of the various processes. The deactivation/neutralization of radioactivity in isotopes by the several demonstrated processes clearly suggest the possibility of full scale processing of radioactive nuclear materials to deactivate radioactive nuclear materials. " ("Radioactivity Deactivation at High Temperature in an Applied DC Voltage Field Demonstrated in 1964". Larry Geer & Cecil Baumgartner, http://www.gdr.org/nuclear_half.htm)

Update 8-4-11:

"Thirty years ago, Otto Reifenschweiler was searching for a compound which could protect Geiger-Mueller tubes from damage when they are first ionised. He found the compound, which became a money-spinner for Philips, in a mixture of titanium and radioactive tritium. He also discovered that as the mixture was heated, its radioactivity declined sharply. No process known to physics could account for such a baffling phenomenon: radioactivity should be unaffected by heat. Nevertheless, as the temperature increased from 115°C to 160°C, the emission of beta particles fell by 28%." ("High temperature suppresses radioactive decay", Science Frontiers, Mar-Apr- 1994, <http://www.science-frontiers.com/sf092/sf092c14.htm> ; Physics Letters A ("Reduced radioactivity of tritium in small titanium particles," Vol. 184, pp. 149-153; see also <http://www.infinite-energy.com/images/pdfs/MalloveIE54Radio.pdf>)

“The ‘Reifenschweiler effect’ is the observation that the beta-decay of tritium half-life 12.5 years is delayed reversibly by about 25-30% when the isotope is absorbed in 15 nm titanium-clusters in a temperature window in between 160-275 C. Remarkably at 360 C the original radioactivity reappears. The effect is absent in bulk metal. Discovered around 1960/1962 at Philips Research Eindhoven, The Netherlands Reifenschweiler extensively discussed his observation with o.a Casimir (the director of research at the time), Kistemaker (ultracentrifuge expert), and although no satisfactory explanation was found, R. was allowed to publish it. At the time a unique example as to how an electronic environment might affect nuclear phenomena.” (<http://pages.csam.montclair.edu/~kowalski/cf/311alberts.html>)

Update 11-13-11:

"A contribution from R. Monti described the suppression of the radioactivity of thorium oxide. Monti's method was similar to the method worked on in the summer of 1992. He could reduce the activity from 900 cpm to about 100 cpm in four days of a series of sudden heatings.

Possibilities of de-naturing radioactive wastes appears and have been further developed by Monti and separately by Hal Fox (2003)." <http://www.lenr-canr.org/acrobat/BockrisJthehistory.pdf> "The History Of The Discovery Of Transmutation At Texas A&M University", J.O'M. Bockris, Molecular Green Technology, College Station, Texas 77845, Revised Version, 6th of August, 2003

See also:

"Cool solution to waste disposal" (2006; Claus Rolfs, Ruhr University) <http://phys.org/news73578268.html>
<http://www.theengineer.co.uk/news/waste-solution/295563.article>

"Half-life heresy: Accelerating radioactive decay", Aussiegirl (2006) http://aussiehule.blogspot.com/2006/10/half-life-heresy-accelerating_23.html

the extraordinary claims of Dr. Champion at: <http://www.drjoechampion.com/History/x-files/neurad01.htm> and Update 4-5-12 below.

Update

"The Road to Remediation of Radioactive Waste? Mitsubishi Heavy Industries Proceeds Toward Practical Research" (Nikkei, April 8, 2014 by Yoshikazu Miura):

"Mitsubishi Heavy Industries has established technology based on a low-energy nuclear reaction concept of the transmutation of elements. For example, the transmutation of cesium was experimentally confirmed to increase, by an atomic number of four, to praseodymium, without the use of a large-scale nuclear reactor or accelerator.

The company is moving from a fundamental research stage into a practical research stage. Their technology may open the path to clean nuclear transmutation technology. Mitsubishi Heavy Industries, a primary manufacturer of nuclear technology, is eager to use the technology in a practical application to convert radioactive strontium and cesium waste into harmless non-radioactive elements."

(Refs: "Nuclide transmutation device and nuclide transmutation method", EUROPEAN PATENT SPECIFICATION EP 1 202 290 B1

<http://www.freepatentsonline.com/EP1202290B1.pdf>

<http://news.newenergytimes.net/2014/04/24/nikkei-reports-mitsubishi-to-use-lenrs-to-clean-nuclear-waste/>

For some possible explanatory clues about these effects see:

[./qmconcept.htm#SpinOrbitCoupling](#) ;

[/issues.html#HydrogenLike](#)

[/4v4a/ADVPWR.html#ExcessMass](#)

Update 1-16-12:

"The conflict for radiometric methods is that zircons in Precambrian granite display huge helium concentrations [15]. When the amounts of uranium, lead, and helium are determined experimentally, one finds amounts of lead and uranium consistent with more than a billion years of nuclear decay at presently measured rates. Amazingly, most of the radiogenic helium from this decay process is also still present within these crystals that are typically only a few micrometers across. However, based on experimentally measured helium diffusion rates, the zircon helium content implies a time span of only a few thousand years since the majority of the nuclear decay occurred.

So which physical process is more trustworthy -- the diffusion of a noble gas in a crystalline lattice or the radioactive decay of an unstable isotope? Both processes can be investigated today in great detail in the laboratory. Both the rate of helium diffusion in a given crystalline lattice and the rate decay of uranium to lead can be determined with high degrees of precision. But these two physical processes yield wildly disparate estimates for the age of the same granite rock. Where is the logical or procedural error? The most reasonable conclusion in my view is that it lies in the step of extrapolating as constant presently measured rates of nuclear decay into the remote past. If this is the error, then radiometric methods based on presently measured rates simply do not and cannot provide correct estimates for geologic age.

But just how strong is the case that radiometric methods are indeed so incorrect? There are dozens of physical processes which, like helium diffusion, yield age estimates orders of magnitude smaller than the radiometric techniques. Many of these are geological or geophysical in nature and are therefore subject to the question of whether presently observed rates can legitimately be extrapolated into the indefinite past. . . . "

There are other processes which are not as easy to express in quantitative terms, such as the degradation of protein in a geological environment, that also point to a much shorter time scale for the geological record. It is now well established that unmineralized dinosaur bone still containing recognizable bone protein exists in many locations around the world [17]. From my own first hand experience with such material, it is inconceivable that bone containing such well preserved protein could possibly have survived for more than a few thousand years in the geological settings in which they are found." "Highlights of the Los Alamos Origins Debate", John R. Baumgardner, Ph.D. (and Nicholas Petersen) <http://creationontrial.com/articles/The-Los-Alamos-Origins-Debate.htm> ; <http://www.icr.org/rate/>

Update 4-5-12

"Transmutations of radioactive isotopes?", Ludwik Kowalski,
2004, <http://pages.csam.montclair.edu/~kowalski/cf/186radwaste.html>

Update 10-15-12

Another problem that enters into the radioactive dating controversy pertains to the nature of time itself. Physicists are trying to get rid of "time" as a *fundamental* concept. Einstein said "...for us physicists believe the separation between past, present, and future is only an illusion, although a convincing one." For him, time was illusory. Modern physicists have been moving in that direction too, and for good reasons. They have, and are, realizing that in the equations of physics, time is not fundamental. In quantum mechanics, for instance, its use is merely parametric. In Einstein's $E=mc^2$ equation, time does not appear separately, but only as a component of motion. Physicists believe that the use of *motion*, instead of time, would be more fundamental (and perhaps even easier to use). The implications are enormous and mind-boggling.

For related issues, see "[In Search of the Geometry of Space, Time, and Motion](#)". The article is about a search for a metric for "distance" that the Universe actually uses (not just the theoretical ones in the textbooks); the application is space travel, and additionally "non-locality", and some other weird phenomena that are very hard to describe, let alone explain. Time is "physically" involved in these problems.

12-18-14

"Piezonuclear decay of thorium", Fabio Cardonea, Roberto Mignanib, Andrea Petrucci, *Physics Letters A*, Volume 373, Issue 22, 11 May 2009, Pages 1956–1958
(<http://www.sciencedirect.com/science/article/pii/S0375960109004113>)

Abstract

"We show that cavitation of a solution of thorium-228 in water induces its transformation at a rate 10^4 times faster than the natural radioactive decay would do. This result agrees with the alteration of the secular equilibrium of thorium-234 obtained by a Russian team via explosion of titanium foils in water and solutions. These evidences further support some preliminary clues for the possibility of piezonuclear reactions (namely nuclear reactions induced by pressure waves) obtained in the last ten years."

"Piezonuclear neutrons from fracturing of inert solids", F. Cardone, A. Carpinteri, G. Lacidogna (March 2009) (<http://arxiv.org/abs/0903.3104>)

"Neutron emission measurements by means of helium-3 neutron detectors were performed on solid test specimens during crushing failure. The materials used were marble and granite, selected

in that they present a different behaviour in compression failure (i.e., a different brittleness index) and a different iron content. All the test specimens were of the same size and shape. Neutron emissions from the granite test specimens were found to be of about one order of magnitude higher than the natural background level at the time of failure."

There is more information at:

http://staff.polito.it/alberto.carpinteri/piezonuclear%20reactions%20conference/the%20atom%20unexplored_carpinteri.pdf

<http://www.formatex.info/energymaterialsbook/book/769-780.pdf>

4-26-15

"A cool solution to waste disposal", *Physics World*, Edwin Cartlidge (2006) <http://physicsworld.com/cws/article/news/2006/jul/31/a-cool-solution-to-waste-disposal>

"The group has investigated this hypothesis by embedding a number of radioactive nuclei inside metals and then cooling the metal to a few degrees kelvin. As expected, they observed a longer half-life for the electron capture of beryllium-7 and shorter half-lives for β^+ -decay in sodium-22 (*Eur. Phys. J. A* 28 251) and α -decay in polonium-210. They are now investigating the α -decay of radium-226, a hazardous component of spent nuclear fuel with a half-life of 1600 years. [Claus] Rolfs calculates that this half-life could be reduced to as little as a year and at the very least to 100 years, and believes that the half-lives of all other hazardous alpha emitters within nuclear waste could be shortened by similar amounts."

Another Afterthought: Direct conversion of radioactivity to electricity

<edit in progress>

About 200 hundred years ago the electron began to be used as a new carrier of energy. Today, neutrino technology is about where the electron technology was about 200 years ago. But the neutrino is a much more versatile particle and is capable of some clever tricks. Some of the unconventional energy devices you may read about may have something to do with neutrinos. (See [../4v4a/ADVPROP.html#NeutrinoPerspective](http://4v4a/ADVPROP.html#NeutrinoPerspective))

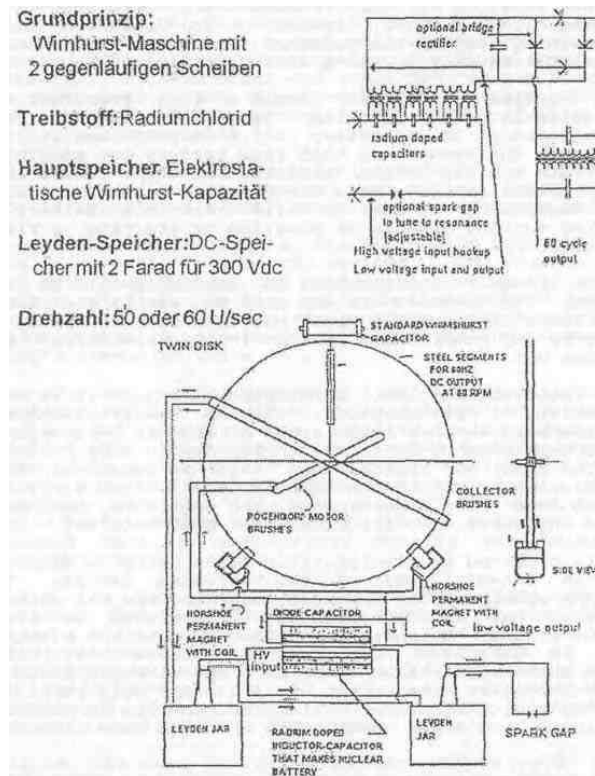
Unconventional:

"Apparatus for Direct Conversion of Radioactive Decay Energy to Electrical Energy", Paul M. Brown, (1989) <http://www.freepatentsonline.com/4835433.pdf>

Using a one millicurie radium needle 39, 200 grams of uranium 33 and 100 grams of powdered thorium 31 in the configuration shown in FIGS. 2 and 3, at 86 kiloHz, 20 a continuous output of 23 amperes at 400 volts into a resistance load has been achieved. A configuration utilizing additional radium needles 53, as shown in FIG. 4, may be used to achieve higher power outputs.

While I have shown and described the preferred 25 embodiment of my invention, it will be apparent to those skilled in the art that this invention is not limited to the specific structure described herein and that numerous changes and variations may be made therein 30 without departing from the spirit of the invention or exceeding the scope of the appended claims.

Testatika:



Testatika drawing by Dr. Gordon Freeman

The note at the bottom center reads:

"RADIUM DOPED INDUCTOR-CAPACITOR THAT MAKES NUCLEAR BATTERY"

Conventional:

"Self-Powered Device, Steven J. Helenius (1997) <http://www.freepatentsonline.com/5642014.pdf>

"Device for Converting Nuclear Energy into Electrical Energy", Wilson Greatbatch (1974) <http://www.freepatentsonline.com/3836798.pdf>

"Power Source Using a Photovoltaic Array and Self-Luminous Microspheres", Howard C. Rivenburg (1995) <http://www.freepatentsonline.com/5443657.html>

Use of asymmetric alternating current in charging/plating/polishing

"Process and apparatus for renewing exhausted primary, more particularly dry, electric cells or batteries," Ernst Beer, June 26, 1956. (<http://www.freepatentsonline.com/2752550.pdf>)

Some interest by NASA (http://pages.ripco.net/~marnow/uk/NASA_Vargo_Start.html) :

". . . it is well known in the plating field that periodic current reversal methods can plate coatings at a much faster rate than can be done by conventional direct current methods. It is further known that the reverse-current part of the charging cycle will tend to act as a depolarizer. Use of this technique should lead to significantly higher battery-charging rates. Furthermore, a problem with dc chargers is that the electrode material is plated on as a loose, spongy mass which often falls off and ultimately leads to battery failure. The current characteristic of this battery charger is similar to that used in electropolishing circuits and because of this characteristic, electrode material should be replated as a smooth, hard surface (ref. 1), thereby contributing to increased reliability and long life." (Brief Investigation of an Asymmetrical Alternating-Current Battery-Charging Technique by Donald J. Vargo)

From the original patent, <http://www.freepatentsonline.com/2752550.pdf> :

". . . a current is passed through the cells or batteries to be treated, consisting partly of alternating current and the remainder of direct or pulsating direct current. For charging or renewing normal commercial cells or batteries, the treating circuit can therefore include a rectifier with a very considerable leak (50-90%) or a rectifier bridged by a resistance. . . . Experiments with dry hearing aid batteries and pocket lamp batteries have shown, that by a treatment according to the invention the life of such batteries can be lengthened to 20 to 30 times the normal life."

The process was originally intended for *primary* batteries, which were not intended to be recharged. This technology comes from the 1950s and can easily be done today, even by hobbyists (or as a science fair project). Wouldn't you like to have rechargeable batteries that last 20-30 times normal? Do you think that there would be a market for such a charger? Especially for car batteries . . . ? For home power plants . . . ?

Links

<http://www.lenr-canr.org/Experiments.htm> http://lenr-canr.org/wordpress/?page_id=187 Shows lots of very detailed color photographs and drawings of cold fusion cells. Also has article "High School Students Do Cold Fusion" which is about the work Prof. John Dash (Portland State University) with high school students as part of the Apprenticeships in Science and Engineering program.

<http://www.altenergy.org/news/newsletter/archive/newsletters/newsletter105.html>

"High School Students Get Results With Cold Fusion Experiment"

<http://blake.montclair.edu/~kowalskil/cf/98demo.html>

"A cold fusion demo at MIT"

http://physics.pdx.edu/faculty_files/das/dash.htm More about Dr. Dash and his research.

"Fun with fusion: Freshman's nuclear fusion reactor has USU physics faculty in awe"

<http://deseretnews.com/dn/view/0,1249,510054502,00.html> (Sept 2003)

"Take water and potash, add electricity and get - a mystery", By Robert Matthews, Science Correspondent

<http://www.telegraph.co.uk/news/main.jhtml?xml=/news/2003/05/18/ncell18.xml>

Absolutely Not Cold Fusion (MLP) By imrdkl, Jun 3rd, 2003

<http://www.kuro5hin.org/story/2003/6/2/55742/14178>

<http://rexresearch.com/eccles/1eccles.htm> (WO 00/25320 patent info)

<http://www.hydrino.org/Labs/Anomalous-Heat-from-Atomic-Hydrogen.pdf>

<http://patft.uspto.gov/netacgi/nph->

[Parser?Sect1=PTO1&Sect2=HITOFF&d=PAL1&p=1&u=/netahtml/srchnum.htm&r=1&f=G&l=50&s1=5273635.WKU.&OS=PN/5273635&RS=PN/5273635](http://patft.uspto.gov/netacgi/nph-Parser?Sect1=PTO1&Sect2=HITOFF&d=PAL1&p=1&u=/netahtml/srchnum.htm&r=1&f=G&l=50&s1=5273635.WKU.&OS=PN/5273635&RS=PN/5273635)

<http://jlnlabs.imars.com/cfr/html/hpcfr21.htm> (Experiments of Jean-Louis Naudin)

<http://www.amasci.com/weird/anode.txt>

COLD FUSION BY PLASMA ELECTROLYSIS OF WATER

<http://guns.connect.fi/innoplaza/energy/story/Kanarev/coldfusion/>

CR-39 alpha detector chips and electrolysis of Li_2SO_4

<http://blake.montclair.edu/~kowalskil/cf/108oriani.html>

http://www.gdr.org/nuclear_half.htm (Global Deactivation of Radiation Corp.)

<http://www.enterprisemission.com/images/hyper/gmarad.jpg> (Good Morning America picture)

<http://pubs.acs.org/cen/science/87/8749sci2.html> ("Tribology All Around", Mitch Jacoby, Chemical & Engineering News, December 7, 2009):

The team found that unrolling tape at a relatively slow rate—just a few centimeters per second—simultaneously leads to visible light and X-ray emission from the spot that the tape separates from the roll. They showed that the X-rays are intense enough to image the bones in a finger by exposing commercial dental X-ray film to the tape-peeling apparatus for about 1 second. Further study revealed that this tribological process induces nanosecond bursts of X-rays with a peak energy of about 15 keV.

Silicon PIN photodiodes can be used for inexpensive radiation detection

<http://www.radiation-watch.org/>

<http://www.newscientist.com/blogs/onepercent/2012/02/diy-geiger-counter-smartphone.html>

<http://www.maxim-ic.com/app-notes/index.mvp/id/2236>

<http://www.carroll-ramsey.com/detect.htm>

<http://www.elektor.com/magazines/2011/june/measure-gamma-rays-with-a-photodiode.1810862.lynkx>

Beta Glucan can improve radiation exposure survival rates

<http://www.beta-glucan-13d.com/images/radiation.pdf>

<http://www.beta-glucan.com/beta%20glucan%20radiation.htm>

<http://www.betaglucan.org/R-Z.htm> , <http://www.beta-glucan-info.com/radiation-exposure.htm>

DeconGel used to "peel up" contaminants

<http://singularityhub.com/2011/05/31/miracle-blue-goo-used-to-decontaminate-japans-nuclear-disaster-video/>

"Technology makes storing radioactive waste safer", 31 October

2011, <http://www.qut.edu.au/about/news/news?news-id=37568>

"[Professor Huai-Yong Zhu](#) from [QUT Chemistry](#) said the world-first intelligent absorbent, which uses titanate nanofibre and nanotube technology, differed from current clean-up methods, such as layered clays and zeolites, because it could efficiently lock in deadly radioactive material from contaminated water.

The used absorbents can then be safely disposed without the risk of leakage, even if the material became wet."

Deinococcus

radiodurans (https://en.wikipedia.org/wiki/Deinococcus_radiodurans)

"***Deinococcus radiodurans*** is an [extremophilic bacterium](#), one of the most [radiation-resistant](#) organisms known. It can survive cold, dehydration, vacuum, and [acid](#), and is therefore known as a [polyextremophile](#) and has been listed as the world's toughest bacterium in [The Guinness Book Of World Records](#). . . . As a consequence of its hardiness, it has been nicknamed [Conan the Bacterium](#).

D. radiodurans is capable of withstanding an acute dose of 5,000 [Gy](#) (500,000 rad) of [ionizing radiation](#) with almost no loss of viability, and an acute dose of 15,000 Gy with 37% viability. A dose of 5,000 Gy is estimated to introduce several hundred double-strand breaks (DSBs) into the organism's DNA (~0.005 DSB/Gy/Mbp (haploid genome)). For comparison, a chest X-ray or Apollo mission involves about 1 mGy, 5 Gy can kill a human, 200-800 Gy will kill [E. coli](#), and over 4,000 Gy will kill the radiation-resistant [tardigrade](#).

Deinococcus has been [genetically engineered](#) for use in [bioremediation](#) to consume and digest [solvents](#) and [heavy metals](#), even in a highly radioactive site."

html 7/02

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Advanced Atomic Energy Converters

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Negative Knowledge

Many years ago I was browsing in a college book store, looking for three good books on quantum mechanics. Quantum mechanics is a heavily mathematical theory that deals with the behavior of things that are very small, such as atoms. The theory involves bizarre concepts like "matter waves," "quantum tunneling," and "non-locality." Despite this, it has had many impressive successes, and because my field of study was chemical engineering, I felt a background in quantum mechanics could be useful. But good books on the subject were very hard to find.

As I was reading the preface of one of the books I had found, I noticed it said something like this: "After you study the entire book, do all the exercises, and get an 'A' in the course, you will then

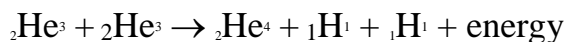
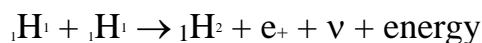
thoroughly understand why quantum mechanics is completely beyond the comprehension of the human mind."

At that time I was a naive student attending college with the equally naive intent of getting an education, not just getting a degree. I was astonished that a science author would say such a thing, and reread it in disbelief. To say that we do not understand the universe is one thing. But to say that it is certifiably incomprehensible in its intrinsic nature is quite another matter. This made the universe seem downright unfriendly. It was also a betrayal of the idea of education. I wanted to *understand* the universe, not be "educated" in why it was incomprehensible! Was the author saying that after I took the class and did all that hard work, I would know *less*? This seemed to be a kind of "negative knowledge"—the more I learned, the less I would know. By the time I graduated, I would be an idiot! ☺ (Not long after that I dropped out of college.)

As the years went by I encountered more of this negative knowledge, but with a difference. I was not in college anymore. I was getting *my* education and I was in control of it. I got a feeling of liberation every time I managed to cast off one of these intellectual power drains. You have seen many such examples in the pages of this booklet. I would like to share one more with you. It is about how stars produce energy.

Stellar Power Production

The astronomy textbooks say that stars like our sun produce energy by a special set of nuclear reactions called "hydrogen burning." In the notation of science, it looks like this:



Some explanation of the notation will be helpful. The _{subscripts} denote atomic number and the _{superscripts} denote atomic mass. The Greek letters, γ (gamma) and ν (nu) are the symbols for gamma rays and neutrinos, respectively. The e^+ stands for the positron.

${}_1^1\text{H}$ is the common "protium" isotope of hydrogen. This type of hydrogen is extremely abundant in the universe and in the sun. ${}_1^2\text{H}$ is the much less abundant "deuterium" isotope that is used in the hydrogen bomb. ${}_2^4\text{He}$ is common helium, and ${}_2^3\text{He}$ is a very rare isotope of helium. These equations state that energy can be produced by the "fusion" of hydrogen atoms into helium atoms (this is not, however, the particular type of reaction that takes place in the hydrogen bomb).

This scheme was proposed in 1939 and has become widely accepted for more than half a century. Few scientists would suspect that it is totally wrong. Nor would most scientists suspect that this "knowledge" actually *decreases* our understanding of the universe. Keep this in mind as you read the rest of this paper.

Stars do *not* generate their power by the conversion of hydrogen into helium.

As explained above, stars such as our sun are thought to generate their power by converting hydrogen into helium. There are some blatant problems with this "fact" however:

1. There is no hydrogen in the core of the sun. The commonly accepted belief is that the sun generates most of its power by fusing hydrogen into helium in its hot central core. The sun does contain enormous amounts of hydrogen and helium but there is no reason to believe that these elements exist in the central core of the sun. Spectroscopic studies show that there are at least 67 atomic elements in the sun. This represents a range of atomic mass from 1 (hydrogen) to 238 (uranium). The sun is so hot that all the chemical/molecular compounds and atomic aggregates break up into single atoms and exist in the form of gas. Atoms with the highest atomic mass numbers will therefore gravitate towards the center of the sun. This will displace lighter elements like hydrogen and helium outward towards the surface. The central core of the sun will therefore contain elements that are heavier—indeed *much* heavier—than hydrogen and helium (helium itself is four times as massive as mono-atomic hydrogen)

Critics will point out that hydrogen is 1,000 to 10,000 times more abundant than heavier elements such as carbon, nitrogen, oxygen, silicon, sulfur, neon, and iron. In fact all elements beyond the iron-cobalt-nickel group are very scarce, so only the first 28 elements in the Periodic Table of chemical elements would seem to have a significant bearing on the structure of the sun. According to the critics, these elements would just be contaminants in an ocean of hydrogen and would not be enough to exclude hydrogen from the intensely hot central region of the sun.

However, the elemental composition of the sun is derived from spectroscopic studies of its *atmosphere*. This does not tell us much about the composition of the interior:

"Spectral lines reveal much about the chemical composition of the Sun's outer layers, but they do not hint at the internal chemical composition of the Sun, which is quite different from the outer layers."
(*Understanding the Universe*, Philip Flower, 1990, p.426)

Suppose a truckload of cork balls were to be mixed with the water in a swimming pool. The corks would eventually come to the surface where they can be seen. This may leave the impression that the pool is filled with them, but in fact they are only in the upper couple of feet. Hydrogen is the lightest of all elements. It will come to the surface region of the sun just like the corks in the swimming pool.

The central region of the sun is also the region of highest temperature. The outer layers of the sun may be 5,000-10,000 Kelvins but the central interior, 15 million Kelvins. Massive atoms like iron, therefore, not only gravitate to the center, they also get heated up the hottest. And the hotter the gas, the more volume it takes up. The iron would be 1000 times hotter than the hydrogen and atom for atom would take up 1000 times the volume of hydrogen at the cooler temperatures. This is also true of the other elements heavier than hydrogen. The fact that these elements are much more massive than hydrogen, and the fact that they gravitate to the hottest region and require more "elbow room," both conspire to push the hydrogen to the cooler outer regions.

In the sun, power is apparently produced in bursts rather than continuously. The bursts occur in eleven year cycles. This behavior itself appears to be incompatible with the "hydrogen burning" hypothesis, which would seem to favor continuous burning.

See also the [fifth objection](#).

Links:

"Sun's Iron Core May Be Cause Of Solar Flares", Dr. Oliver Manuel, (3 November 2003) http://www.scienceagogo.com/news/20031002191731data_trunc_sys.shtml

"Why the Model of a Hydrogen-filled Sun is Obsolete", O. Manuel (2002) <http://arxiv.org/ftp/astro-ph/papers/0410/0410569.pdf>

"Vast Solar Eruption Shocks NASA and Raises Doubts on Sun Theory", John O'Sullivan, Jan 3, 2011, <http://www.sott.net/article/220912-Vast-Solar-Eruption-Shocks-NASA-and-Raises-Doubts-on-Sun-Theory>

"The Sun is a ball of Iron (well, mostly iron)", <http://www.thesunisiron.com/>

"Abundances of Trans-Iron Elements in Solar Energetic Particle Events", Donald V. Reames, Aug, 2000, *Astrophysical Journal*, 540:L111–L114, 2000 September 10, <http://iopscience.iop.org/article/10.1086/312886/pdf>, <http://epact2.gsfc.nasa.gov/don/00HiZ.pdf>

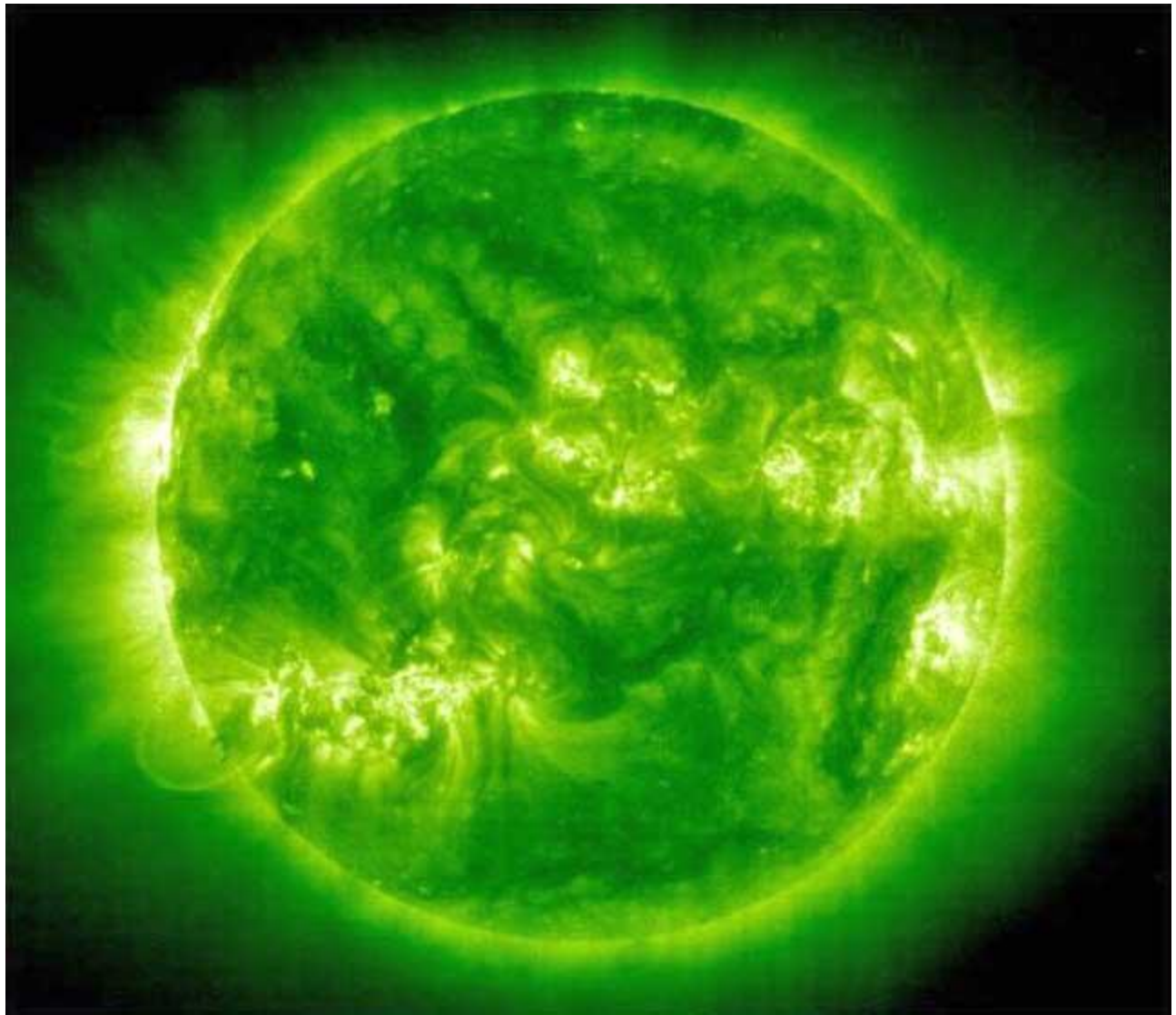
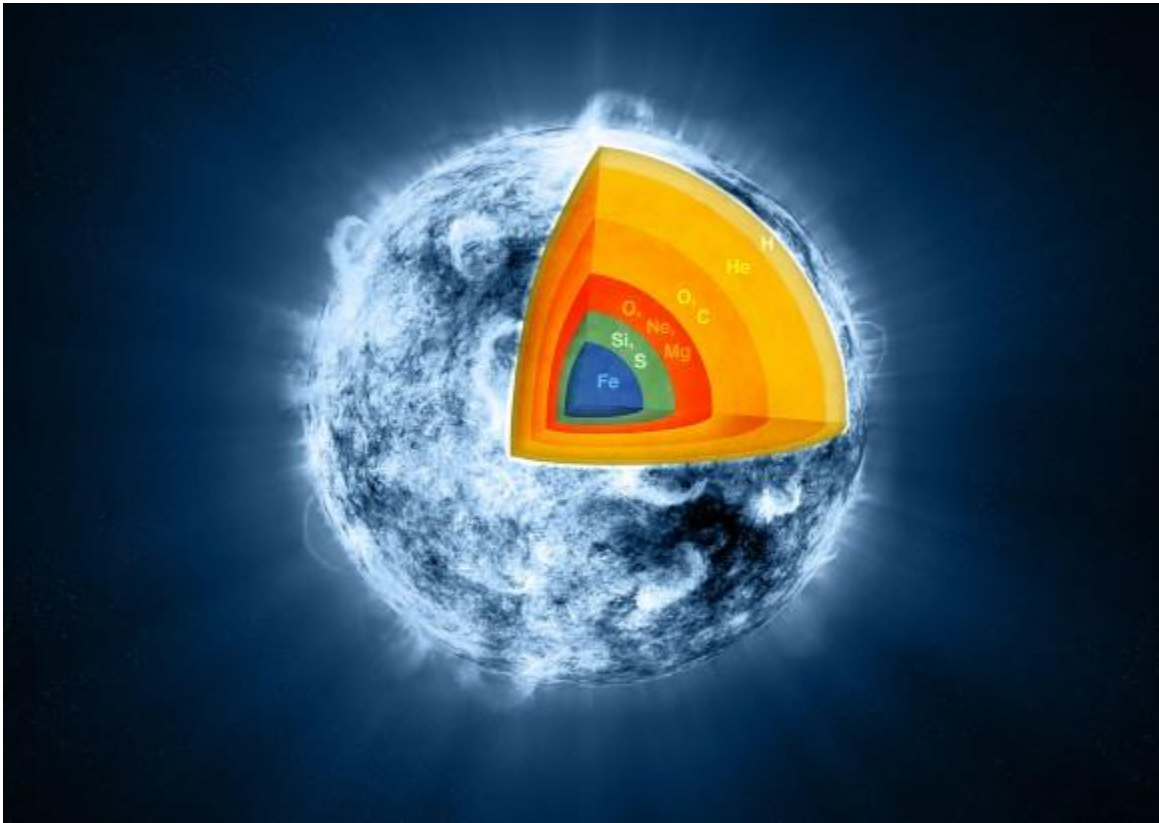


Image of the Sun shown in light of highly ionized iron (FeXII)

Credit: SOHO-EIT Consortium, ESA, NASA

http://www.americanscientist.org/include/popup_fullImage.aspx?...



Caption: "Illustration of the pre-supernova star in Cassiopeia A. It's thought that its layers were "turned inside out" just before it detonated. (NASA/CXC/M.Weiss)"

<http://www.universetoday.com/109557/stars-boil-before-they-blow-up-says-nustar/#more-109557>

The theory used to be that a blue super giant turns into a red supergiants (somehow) just before the star blows up. Now the theory is that the star turns inside out (putting the hydrogen on the surface, where common sense says it is supposed to be, and the iron at the core, where it is supposed to be) just before it blows up!

The article states:

One of the most valuable achievements of the recent NuSTAR findings is having a new set of observed constraints to place on future models of core-collapse supernovas... which will help provide answers — and likely new questions — about how stars explode, even hundreds or thousands of years after they do.

Here is another one: "AN IRON-RICH SUN AND ITS SOURCE OF ENERGY", O. Manuel† and A. Katragada (2004) <http://www.omatumr.com/abstracts2005/IronRichSun.pdf> :

Mass-fractionation enriches light elements and the lighter isotopes of each element at the solar surface, making a photosphere that is 91% H and 9% He. However, the solar interior consists mostly of seven, even-numbered elements of high nuclear stability - Fe, O, Ni, Si, S, Mg and Ca. These elements were made in the deep interior of the supernova that gave birth to the solar system 5 billion years ago. They comprise 99% of ordinary meteorites.

And another: "Why the Model of a Hydrogen-filled Sun is Obsolete ", O. Manuel, Nuclear Chemistry, U. Missouri-Rolla: (2002) <http://arxiv.org/ftp/astro-ph/papers/0410/0410569.pdf> :

When this empirical power law, defined by enrichments of light isotopes in the solar wind, was applied to solar atmospheric abundance, the most abundant elements in the Sun were found to be iron (Fe), nickel (Ni), oxygen (O), silicon (Si), sulfur (S), magnesium (Mg), and calcium (Ca) [p. 283]. These elements all have even atomic numbers, they are made in the interior of supernovae, and they are the same seven elements Harkins found in 1917 to comprise 99% of ordinary meteorites.

Emission from iron ions at 600,000

kelvin http://www.americanscientist.org/include/popup_fullImage.aspx?key=L7qYdEAfHUX9vvOif7iehZ4vK8UBdhE3HxWYrp5bAf3RYTy8ngXILwIWkE2e/kifUbXvu8Dg874=

One of the best (and cheapest) "constraints to place on future models" is plain old **common sense** !

"Fools are put in many high positions"
Ecclesiastes 10:6

2. The conversion of hydrogen into helium requires very improbable atomic transformations:

"It happens that the proton-proton chain, very important in the sun, begins with a most improbable event: the collision of two protons resulting in the formation of . . . the heavy isotope of hydrogen called *deuterium*. Usually the formation of a compound nucleus of two protons simply breaks up into two protons again, rather than ejecting a positron and turning into a deuteron, and very many compound nuclei must form to produce appreciable amounts of deuterium. But even at the high temperatures of stellar interiors . . . it is extremely hard for two positively charged nuclei to come together to undergo any kind of reaction. . . . One might not expect nuclear reactions to occur at all in stars." (*Exploration of the Universe*, George Ogden Abell, D. Morrison, S.C. Wolff, 5th edition, 1987, p. 520.)

Reread that a few times. Do nuclear reactions of "any kind" that produce "appreciable amounts" of the right kind of atoms sound very likely at stellar temperatures? How would stars that are even cooler than the sun power themselves? (I respect this textbook, incidentally, as one of the more honest ones in the field of astronomy)

The overall equation here is that of a very stable isotope of hydrogen converting itself into a very stable isotope of helium by a very improbable route. Nature simply does not work this way.

Even if the deuterium could be produced by quantum tunneling, it must combine with ordinary hydrogen to produce helium-3. Natural helium has a composition of 99.99986% He^4 and 0.00014% He^3 . If the reaction went this way, there should be much more He^3 around.

Furthermore, two atoms of rare He^3 would have to find each other in the vast volumes of hydrogen and He^4 and combine to produce one atom of He^4 and two atoms of ordinary hydrogen. I think it is clear that the only thing that can drive an equation like

this is the need physicists feel to offer some kind of explanation for the origin of stellar power!

3. Stars can produce enormous bursts of energy extremely rapidly.

An entire star—which may be a couple million miles in diameter—can blow itself to pieces in a stupendous explosion called a "supernova."

"Briefly outshining its home galaxy, the explosion, known as a type 1a supernova, unleashes the equivalent of 10^{28} megatons of TNT—enough energy to destroy an entire solar system." (Science News, August 15, 2009, p. 22)

During a supernova explosion the material ejected can move outward at initial speeds as high as 10,000 to 20,000 km/sec (at least a couple thousand times faster than a detonation wave in a high explosive like TNT). This kind of energy production cannot be based on improbable meetings of widely separated rare isotopes which combine through improbable nuclear reactions. Rather, there is quick energy here in abundance! The commonly accepted power process and its relatives cannot account for it.



Source: NASA Chandra capt_photo_1266481592692-1-0.jpg

Another problem is that the explosion of a star is believed to occur when the conventional fuel is all used up:

"It is our present understanding that the supernova explosion happens at the end of the stellar evolution and therefore most of the nuclear energy has been used up already. There must be another energy source." (*Introduction to Stellar Astrophysics*, Volume 1, Erika Böhm-Vitense, 1989 (Cambridge), p. 179)

This other energy source, known as "gravitational collapse," turns out to be another myth of modern stellar astrophysics (one which I will not pursue in this paper). It is enough to realize that a power source that can blow up a star can also power it in the steady state for a long time.

It is worth noting that the production of steady state power is itself a problem. Blue supergiants—stars that have 50 to 100 times the mass of the sun—shine with

luminosities a million times greater than the sun. The commonly accepted power processes cannot account for the power output of blue super giants like Rigel (the brightest star in the constellation Orion).

4. The neutrino flux from the sun is much less than expected.

According to the Standard Solar Model there are several neutrino producing nuclear reactions in the sun. The neutrino flux at the earth's surface should be about 66 billion/cm²/sec. A very small proportion of these should be detectable. The standard theories predict that a chlorine 37 type of detector should see a flux of 7.9 ± 2.6 Solar Neutrino Units (SNU), but the actual results have been about 2.1 ± 0.3 SNU. Overall, experiments of differing experimental design and more than 25 years of observation and refinements have detected *less* than one-third to one half the expected number of neutrinos. This has left astronomers in quite a quandary:

"Any modifications of the solar model . . . would have profound implications for astronomy. The only direct signal of the stellar nuclear reactions predicted by the standard model is the neutrino flux from the sun. The problem is, the prediction seems to be wrong." (Scientific American, May 1990, p.56; see also Sky & Telescope, "Closing in on the Solar-Neutrino Problem", Daniel Fischer, October, 1992, p. 378)

I'll have more to say about neutrinos later in this paper.

5. A supernova explosion reveals the interior composition to be high in elements heavier than hydrogen.

During a supernova explosion, the "outrushing gas has a higher abundance of such . . . elements as silicon, sulfur, argon, and calcium than does the sun. In Type I, but not in Type II, supernovae, the abundances of nickel, iron, and cobalt are also abnormally high". (Abell, *op. cit.*, p. 567)

I suspect two things here. One is that the elemental composition of the sun, instead of being almost entirely hydrogen, is proportionally more like that of all the planets combined, with an extra abundance of hydrogen and helium, especially in the outer observable regions. Another is that when stars blow up, their composition is mainly that of all elements from hydrogen to the iron-cobalt-nickel group and relatively little else (in terms of percentages).

The idea that stellar power is *not* generated by any of the commonly accepted reaction chains has another consequence, namely that our beliefs about stellar ages will be wrong.

Stellar ages are inferred from our beliefs that stars derive their power from converting hydrogen into helium. If our beliefs about this process are erroneous, then stellar ages will have to be revised. Generally this will mean that what are currently believed to be old stars are actually young, and that the young stars are actually old. Because of the implications of this, our views on the evolution of the universe must also change drastically.

Principles outlined in a previous article, *Advanced Stellar Propulsion Systems*, give us reason to believe that the age of a stellar system will correlate directly with the total mass of that system. A

binary star system would be older than a single star. A globular cluster (currently viewed as "very old") would be regarded as much younger than a spiral arm galaxy. The oldest star systems would be the giant spheroidal galaxies like the one in M87.

Mainstream scientists are now beginning to realize that stars may be older than galaxies. (Science News April 15, 1995, Vol 147, No. 15, p. 230 "Keck finding: Did stars predate galaxies?") They are also perplexed by evidence that the universe appears to be *younger* than the oldest stars in the universe. Again, these problems originate largely because of misunderstandings about the true mechanism of stellar power, as well as their belief in the "Big Bang" origin of the universe. (Science News 10/8, 10/22, 10/29 (1994) V146, Nos. 15,17,18, pp. 232-234, 265, 278; 9/9/95 V148. No. 11, p. 166).

"Dr. Tesla disclosed that he has lately perfected instruments which flatly disprove the present theory of the high physicists that the sun is destined to burn itself out until it is a cold cinder floating in space. Dr. Tesla stated that he is able to show that all the suns in the universe are constantly growing in mass and heat, so that the ultimate fate of each is explosion." <http://www.electricitybook.com/tesla-death-ray/>

An Alternative Theory of Stellar Power

Stars obviously generate power. But how do they do it? Here is what the facts suggest to me:

1. Heavy elements gravitate to the center of a star.
2. The center is the hottest part of the star.
3. Heavy elements are probably less stable thermally than lighter elements.
4. If atomic power could be generated by simple, direct, purely thermal degradation of heavy elements, this would account for the extremely quick and energetic burst of power seen in supernova. It would also be a process abundant in steady state power because there are a lot of elements between iron (element number 26) and the end of the Periodic Table (position number 118). Heavy elements are actually rather scarce, but this is consistent with the idea that such elements are burned up in the stars. And such a thermal process would not directly produce neutrinos.

The picture that develops here is that heavy elements must be produced in the vast volumes of interstellar space and that the production process is low in kinetic energy. These elements are then gradually pulled into a star by gravitation. The thermal energy of the star causes them to decrease in atomic number and release a great deal of energy in the form of gamma rays. (I call this process "thermal reversion.") The heavy elements lose mass and are swept downwards in the Periodic Table towards the iron-cobalt-nickel group. These three elements are especially stable, very abundant, and concentrate in the center of the star in very large quantities. If the thermal energy of the star ever gets great enough to revert this group—as it would in massive blue supergiants—the star will quickly generate far more power than its structure can handle and the entire star will instantly explode. It will be no surprise that supernovae spectra show abnormally high abundances of "nickel, iron, and cobalt" just as mentioned above.

The idea that heavy elements are *produced* in interstellar space will not receive an enthusiastic welcome by astronomers. But it would explain a couple of perplexing problems. First, there are "peculiar A stars" that show unusually strong spectral lines of yttrium, silicon, strontium, chromium, europium, and other "rare earth" metals:

"Spectrum analysis indicates abundances which are increased by factors of up to 1000 for the rare earth elements. Astronomers found it hard to believe that the rare earth elements, especially, should be enhanced by such large factors in these stars. . . . There is also the peculiar observation that the enhancement of line strengths depends on the effective temperature of the stars. For the hotter stars, we see strong Si lines; the cooler stars have strong Eu, Sr, and Cr lines" (Böhm-Vitense, *op. cit.*, pp. 128, 135)

The main problem here is that, according to current theory, high abundances of *heavy* elements are not expected to be found in the atmospheres of *cool* stars. The existence of barium-rich and mercury-rich stars present similar difficulties. These problems disappear however, if these heavy elements are produced in interstellar space and are actually on their way *in* to the star instead of being boiled up from the stellar interior. (See also Przybylski's

Star http://en.wikipedia.org/wiki/Przybylski's_star ; Afterthought: this star might not be a good example of this hypothesis; this star pulsates in a way suggestive of gravitational adjustments; it could be an "inverse star" (my own term) where heavy elements gravitate towards the *surface* instead of the center. Such a star will eventually normalize.)

This unexpected distribution also seems to show up in the Sun's corona:

2.1 Three fold overabundance of detected metals

One fact of particular interest to us here is that most detected metals, particularly sodium, magnesium, aluminum, iron and nickel, seem to be about 3 times more abundant in the corona and solar winds than in the photosphere ([1], p. 31, Table 1.2)! Current instrument sensitivity prevents being as affirmative for the other elements, so we do not have much data on their relative abundance status with respect to the photosphere. ("The Corona Effect", Andre Michaud, <http://wbabin.net/ntham/michaud6.pdf>)

Second, the element technetium has been detected in S, M, and N type stars. In so far as we can determine, technetium does not occur naturally on earth. It is produced here artificially in atomic reactors and cyclotrons, hence its name. It is radioactive and has a half-life of "only" about 4.2 million years. If it is produced in the supposed "nuclear furnace" in the interior of a star, this half-life is too short for it to reach the star's atmosphere where it can be seen in stellar spectra. So what produces this unstable element?

Again, the explanation is that whatever process produces the other heavy elements can produce this one just as well. Production is not the problem; it is the instability of the technetium atom. The implication is that the technetium in interstellar space must be more stable than the technetium near the star. Yet radioactive half-lives are remarkably constant and are not affected by changes in temperature, pressure, electric fields, gravity, etc. Why would technetium, or even the transuranium elements, be any more stable in interstellar space than here on earth?

Some insights about atomic stability can be gleaned from the Periodic Table of chemical elements. (The Periodic Table is that big chart of chemical symbols that is customarily displayed in chemistry

and physics classrooms.) The periodicity in this table implies that there should be 118 elements. But elements 93 to 118 (the transuranium elements) are all unstable and do not occur naturally in the terrestrial environment. They decay radioactively primarily by mass ejection (alpha particle emission and spontaneous fission), implying that they are too massive for local stability. Note that the mass limit implied by the Periodic table is 2×118 or 236. It is thus no coincidence that all atoms that have a mass near or above 236 are radioactive and decay into elements that have less mass.

But if the Periodic table has a mass limit of 2×118 , then element number 92 (uranium) "should" have a mass of 2×92 or 184. The mass of its most common isotope is actually 238. What accounts for this "excess mass" of 54 atomic mass units? Also, elements in the middle of the Periodic Table have excess mass. Are they also unstable?

Atomic stability is related to both mass and atomic number. When an atom has too much overall mass (mass above 236), it undergoes alpha (α) decay. Alpha emission causes an atom to decrease by four units of atomic mass and to decrease by two in atomic number. For example, uranium decays into thorium by alpha emission: ${}_{92}\text{U}^{235} \rightarrow {}_{90}\text{Th}^{231}$ (the subscripts denote atomic number and the superscripts denote atomic mass).

When an atom has too little or too much mass in relation to atomic number, it will undergo one of two types of beta (β) decay. This type of radioactive decay has no effect on mass but causes the atomic number to increase or decrease. Iodine (element 53), for example, has isotopic masses ranging from 110 to 140. The natural isotope is 127 which is about midway (125) in this range. The *lower* mass isotopes decay by $\beta +$ (positron emission) thereby causing a *decrease* in atomic number (${}_{53}\text{I}^{110} \rightarrow {}_{52}\text{Te}^{110}$). The *higher* mass isotopes decay by $\beta -$ (electron emission) thereby causing an *increase* in atomic number (${}_{53}\text{I}^{140} \rightarrow {}_{54}\text{Xe}^{140}$). The so-called "daughter" isotopes may themselves be unstable and the process may repeat several more times (a so-called "decay chain").

Each type of atom thus has a zone of stability for the relationship between atomic mass and atomic number. Radioactive decay attempts to move the atom to some combination that is more nearly in the middle of this zone. For technetium (and promethium) this zone is very narrow, but technetium should have at least one inherently stable isotope. However, the center of the zone of stability is not simply twice the atomic number. Iodine, for instance, "should" have a mass of 2×53 (106) and this should be the center of its zone of stability. But as explained above, the most stable isotope has a mass of 127. Something has caused the mass of this atom to increase, and something has also displaced the center of the stability zone upwards. The same is true for most other atoms in the Periodic Table.

My beliefs about what causes this are strongly influenced by my studies in "scriptural physics." Consider what the Bible has to say about the literal physical heavens:

From Heb 1:10-12, (NKJV):

You, LORD, in the beginning laid the foundation of the earth,
And the heavens are the work of Your hands.
They will perish, but You remain;
And they will all grow old like a garment;
Like a cloak You will fold them up,

And they will be changed.
But You are the same,
And Your years will not fail.

From Ps 102:25-26 (*NIV*):

Your years go on through all generations.
In the beginning you laid the foundations of the earth,
and the heavens are the work of your hands.
They will perish, but you remain;
they will all wear out like a garment.
Like clothing you will change them and they will be discarded.
But you remain the same, and your years will never end.

From Isaiah 51:6, (*NKJV*):

Lift up your eyes to the heavens,
And look on the earth beneath.
For the heavens will vanish away like smoke,
The earth will grow old like a garment,
And those who dwell in it will die in like manner;
But My salvation will be forever,
And My righteousness will not be abolished."

If someone asked me "How are heaven and earth like a garment?", I would never have guessed that they are alike in that they both grow old and wear out! What a comparison! I have no doubt that the followers of Jesus were just as dumbfounded by his strange talk that "Heaven and earth shall perish". (Mat 5:18, 24:35; Mark 13:31; Luke 16:17, 21:33)

These scriptures refer to the ordinary created heavens, the work of God's hands. They are contrasting the idea of God's utter permanence and unchangability with the impermanence of his own physical creation, the heavens and the earth. Things which are very long lived from our standpoint, are in fact impermanent and transitory from God's standpoint. The language here is that of created things becoming old, being changed, wearing out, passing on, passing through, completing their turn, being altered, being dispersed (not necessarily being destroyed outright). Age and "wear and tear" are thus built-in, major features of this physical universe. (See also Job 13:28, Isaiah 34:4)

How would we recognize the existence of old, worn out matter? The oldest matter should be in the same location as the oldest stars. As mentioned above, the age of a stellar system will correlate directly with the total mass of that system. Therefore the oldest stars will be found in large, tightly wound spiral galaxies or in the supermassive giant spheroidal galaxies. Further, the oldest regions of these galaxies will be their central cores. These galactic cores should therefore be undergoing processes that are capable of dispersing matter into space much like Isaiah's firewood was dispersed "like smoke" blown away by the wind.

Such "active galaxies" are in fact well-known to astronomers. M87 and Centaurus A (NGC 5128) are dramatic examples. The Seyfert galaxies and N-galaxies are probably close relatives. (Astronomers do not attribute this energetic activity to age, however. They instead attribute it to "blackholes"—another myth of modern stellar astrophysics.)

Asserting that old matter is 'somewhere in a galaxy' does not locate it very specifically. Is it in stars? Interstellar gas clouds? Planets? The references in the Bible refer to both the heavens and the earth. The Milky Way galaxy in which our earth resides is one of moderate size and therefore one of moderate age. Apparently some examples of this old, worn out matter must be "on the earth"—in the dirt that we stand on. An aging clock would have to be concealed in something that can experience the passage of a great deal of time. Only atoms have lifetimes anywhere near long enough, and are complex enough to accommodate a clock. Isaiah's "earth beneath" and 'the heavens above' are constructed of atoms, and so the clock—the "wear and tear recorder"—is probably in atoms. As already explained, it is evidently related to the phenomenon of excess mass. The effect shows up most clearly in the heavier two-thirds of the Periodic Table (elements heavier than the iron-cobalt-nickel group). It does not appear to be a random effect because the square of the atomic number divided by the excess mass is approximately constant for a wide range of elements.

If old, worn out, unstable atoms exist, then "young" stable atoms must exist too. For the case at hand, this means there must be such a thing as both young and old technetium atoms. The young technetium atoms would be stable (non-radioactive) and this would allow them to be produced in the vast volumes of interstellar and intergalactic space and much later be pulled into a star under the influence of gravitation. As they enter the star's environment, they emit their telltale spectral lines. The technetium problem is therefore resolved by the concept of atomic age.

We will, of course, be interested in knowing what makes this aging clock tick. Electric clocks have to be plugged into a power source to record time. An hourglass requires a gravitational field to operate. A sunbather requires ultraviolet rays to record time in the form of a sunburn. In a similar vein, if atoms record age by an increase in mass, then what causes the mass increase? What keeps the wear and tear recorder ticking away for billions of years? (Imagine designing something that had to run this long!)

One clear candidate is the all-pervasive flux of neutrinos. The universe is full of neutrinos much like it is full of starlight. Like atoms, neutrinos are also stable and presumably possess enormous lifetimes. Further, they interact so extremely weakly with matter that most of them will pass right through the earth (and even stars) as though nothing were in their path. Additionally, the neutrino flux is much higher near a star than in interstellar space. These characteristics are exactly those required to drive a long-period atomic aging mechanism. ("About 7 percent fewer solar neutrinos hit detectors when Earth is furthest from the sun, compared with when it's

1-16-2012 Sidebar. This might be relevant information:

"For example, if accelerated radioisotope decay occurred, then alpha-decaying radioisotopes would yield older isochron "ages" than beta-decaying radioisotopes, which is exactly the pattern in the Brahma amphibolites. . . . Because the different radioisotopes are dating the same geologic event, to have produced different "dates" has to mean that the parent radioisotopes have decayed at different rates over the same time period. In other words, the decay of the parent radioisotopes was accelerated by different amounts, the decay of those yielding older "ages" (the alpha-decayers) having been accelerated more. Obviously, if radioisotope decay was accelerated, say during the Genesis Flood, then the radioisotope decay "clocks" could never be relied upon to "date" rocks as many millions of years old. To the contrary, the rocks could still only be a few thousand years old." ("Radioisotope Dating of Grand Canyon Rocks: Another Devastating Failure for Long-Age Geology" by Andrew A. Snelling, Ph.D., <http://www.icr.org/article/42/>)

Note the reference to alpha decayers having been subjected to an accelerated radioactive decay. This could happen if some process abruptly "induced" the total mass of each of the then presumably existing elements 93 to 118 above the 236 stability limit. These elements would decay by alpha emission (mass ejection) and effectively disappear from the natural environment. See also [Adventures in Energy Destruction](#) .

closest, says Arthur B. McDonald, director of the Sudbury Neutrino Observatory in Ontario." Science News, Vol 160, No. 8, August 25, 2001, p. 115 http://www.phschool.com/science/science_news/articles/physics_bedrock_cracks.html)

Unfortunately, we do not know much about neutrinos. They are extremely hard to study even though they are very plentiful. They are believed to be massless. The exact mechanism by which they would build up excess atomic mass is unknown, but as implied by a previous article, *Advanced Stellar Propulsion Systems*, the mass increment must come from the space/time ratio that constitutes the neutrino itself, or the space/time that constitutes its motion, or both. These ratios are apparently not operative in the *three* space/time dimensions required for something to be recognized as gravitational mass. The mass increment of the neutrino would therefore be only potential until it can be associated with, or trapped by an atom. Also, the build up of excess mass and the build up of normal mass probably result from two different physical processes.

If radioactive half-lives can be affected by the presence or absence of neutrinos, then chronological ages, as currently determined by radioactive dating methods, will all be questionable. (See also [Brian Fraser's Adventures in Energy Destruction](#) for more insights about a process that can affect radioactive decay rates.)

Update 11-27-08: Researchers believe they have seen variations in the radioactive decay rates of silicon 32, chlorine 36, manganese 54, radium 226, and possibly plutonium 238. The variations are typically a few tenths of one percent and seem to correlate with the yearly variations in Earth-Sun distance. The scattered quotes below are from "Half-Life (more or less)", by Davide Castelvecchi, Science News, Nov 22, 2008, p. 20-23:

" . . . when researchers suggested in August that the sun causes variations in the decay rates of isotopes of silicon, chlorine, radium, and manganese, the physics community reacted with curiosity, but mostly with skepticism."

"Both experiments had lasted several years, and both had seen seasonal variations of a few tenths of a percent in the decay rates of the respective isotopes."

"In those experiments, the decay rate changes may have been related to Earth's orbit around the sun, the Purdue teams says. In the Northern Hemisphere, Earth is closer to the sun in the winter than in the summer. So the sun may have been affecting the rate of decay, possibly through some physical mechanism that had never before been observed."

"The closer to the sun, the denser the shower of neutrinos."

"If the results are confirmed, and nuclear decay is not immutable, perhaps physicists could find a way to speed it up to help get rid of waste from nuclear power plants." (See [Adventures in Energy Destruction](#) for more on this topic)

"About 7 percent fewer solar neutrinos hit detectors when Earth is furthest from the sun, compared with when it's closest, says Arthur B. McDonald, director of the Sudbury Neutrino Observatory in Ontario." Science News, Vol 160, No. 8, August 25, 2001, p. 115

See "Evidence for Correlations Between Nuclear Decay Rates and Earth-Sun Distance", J. H. Jenkins, *et al.* Available online at <http://arxiv.org/abs/0808.3283>

Fix the Thinking, Not Just the Theory

One fallacy that I have repeatedly warned about in this series of science articles is that of a key premise or "fact" being wrong, and much "scientific knowledge" thereafter being derived from this faulty premise or set of facts. Astronomer Halton Arp, in defending his controversial views about quasars and redshifts, encountered this same problem and offered this insight:

"Finally, in response to the authority problem presented by many professional scientists who have an awesome amount of scientific knowledge and competence, I can only say this: it may sometimes be that not to know one thing that is wrong could be more important than knowing a hundred things that are right." (*Quasars, Redshifts and Controversies*, Halton Arp, 1987, p. 179)

The way in which modern science has handled these issues reminds me of the story about the farmer and his high-jumping cow. "My cow jumped over the moon," the farmer states matter-of-factly. But how did the cow escape earth's gravity? What did the cow breathe when it was up there? Why didn't it burn up on re-entry? "Those are just theoretical problems," says the farmer. "We don't understand those theoretical *details* very much. The *fact* is that the cow jumped over the moon. I am kind of embarrassed to prove this to people, so I just *admit* that it is true!" If we accept this—that cows can jump over the moon and return to earth intact—then vast new possibilities and opportunities for the entire human race open up before us. These possibilities will all seem reasonable, *provided we accept the key premise about this one high jumping cow!*

When we find that our conclusions are getting ever more ridiculous and problematic, we especially need to reexamine our facts. We need to find out which facts are really facts and which facts only look like facts. And we can apply the principle, as many physicists would, that "The kind of thinking that got us into this mess is not the kind of thinking that can get us out of it." Indeed, if people were good at separating fact from fiction, and in spotting the mental ruts they get into, we would have a much different society, as well as much different science.

"In questions of science the authority of a thousand is not worth the humble reasoning of a single individual."
--Galileo

Another Route to Clean, Safe, Abundant Atomic Power

The promise of atomic power has been with us for many decades but historically it has proven to be more "pain" than promise. But the realization that stars power themselves by thermal reversion of heavy elements (elements with atomic weights higher than that of iron) offers another possible route to producing clean and safe atomic power.

Thermal reversion should be clean and safe because it does not generate neutrons and requires only ounce quantities of stable, readily available fuel. In contrast, a conventional "nuclear reactor" requires tons of hard-to-obtain, unstable elements such as uranium, and produces tons of radioactive by-products with a wide range of half-lives, and tons of obsolete, radioactive machinery.

A pilot sized, pulsed reactor operating on the reversion principle would heat a microgram of a heavy element to 10^{13} Kelvins for at least 10^{-16} seconds (fantastically hot for an extremely short time). The atoms that undergo reversion would give up two atomic mass units, decrease one unit in atomic number, and emit two gamma ray photons with a total energy of about 1.8 GeV per atom.

An unwanted side-effect of this extremely energetic reaction would be the initiation of a radioactive decay sequence. But the initial heavy element fuel could be chosen such that the intermediate radioactive products would have short half-lives and transform into a stable element through beta decay. (Decay sequences that produce neutrons or alpha particles should be avoided by the designer.) Two examples:

1. Lead 208 would revert to thallium 206. This form of thallium has a half-life of 4.2 minutes and will decay into lead 206 by β - emission. Both lead 208 and 206 are very common, stable, non-radioactive isotopes. (The lead you get at your local plumbing shop is 52% lead 208, 24% lead 206, and 22% lead 207.)
2. Mercury 199 would revert directly to gold 197 without producing intermediate radioisotopes. Gold 197 is the common gold used in jewelry. Mercury 199 comprises 17% of the ordinary elemental mercury found in thermometers.

In principle this type of reactor creates no radioactive waste. In its perfected form, it could "obviate" ☺ the radioactive waste problem.

Economically creating a tiny environment that has the radiative and kinetic properties of 10^{13} Kelvins would be quite an engineering challenge. But these energies are within reach of desktop petawatt lasers. They are also within range of modern 200-300 MeV heavy ion accelerators. The latter are not small machines, but could be made 1000 times smaller, more efficient, and cheaper by adapting superconducting RF quadrupole technologies to laser frequencies. Another promising technology is laser driven wakefield accelerators which could give accelerations as high as 1 TeV per meter. (R&D Magazine, April 1993, p. 54-58)

There are undoubtedly all sorts of ways of reaching these energies. I do not have the time, resources, or background to begin to sort them out. I can only purport to find the right *questions*, and hope that others more qualified and better equipped than I am will find the answers. In any case, the possibility of producing atomic energy by thermal reversion of heavy elements can certainly be investigated with equipment available to scientists today.

Those who are skeptical of such possibilities should keep in mind that mainstream physicists have themselves contemplated generating atomic power cheaply and safely through simple means. One area of recent interest is the production of hydrogen fusion in a "single bubble sonoluminescence chamber." These devices consist of a couple of ultrasonic speakers and a container of water. There is evidence that they can produce temperatures in a tiny bubble that could be as high as several million Kelvin. This has favorable implications for inexpensive atomic power:

"Conditions might be sufficient to combine atoms of the hydrogen isotopes deuterium and tritium, yielding helium nuclei and energy. The reaction would also produce neutrons, which researchers look for as a sign that fusion is occurring. . . . Using fusion as a power source remains a major goal of modern physics. . . . Doing it in the laboratory at a cost of only a couple of thousand dollars seems almost beyond belief." (Science News, Vol. 147, No. 17, April 29, 1995, "Inferno in a Bubble," pp. 266-267)

I believe that there are lots of good gifts tucked away in the Periodic Table of chemical elements, and that these gifts are more likely to be harvested by a thoughtful combination of inexpensive technologies than by the inconceivably expensive government science projects. Our conceptual understanding of atomic physics is still rather primitive and I believe that accurate theoretical

concepts will produce huge and rapid advances in the field of atomic power. (my current favorite is the Papp inert gas engine and its recent variants. See: [../qm/issues.html#PappEngine](http://qm/issues.html#PappEngine) .)

Social Consequences

As you read and ponder this article you will probably come to the following realizations:

- "Scientifically proven fact" may not be as factual as most of us think.
- Beliefs that are "proven beyond question" are worth reexamining periodically.
- It is sometimes necessary to circumvent "the system" and use the backdoors when the front doors don't work.
- The non-expert can make meaningful contributions in almost any field of endeavor.
- The efforts of one person *can* make a big difference.
- With sufficient effort and will, any individual can rise above the predominate culture.

Knowing cannot substitute for *doing*. Action, even in the face of overwhelming odds, is required.

- Things are frequently "impossible" because we merely think they are.
- Examples, especially examples in people, can have a powerful and lasting effect, for better or for worse.

I call these items "strategic principles," and this list is a merely a sample.

This paper was originally intended to illustrate the concept of "stealth values" and "value practice." The premise is that values can be taught through a medium that seemingly has nothing to do with values per se. The principles and values are not explicitly taught. They are supposed to rub off on you as you read and contemplate this paper on atomic power. You may not even realize the extent to which this happens. Or that some of the principles and values you learn in physics become part of your inner nature and affect how you relate to your neighbors and marriage mate. If you want to "teach values" find a vehicle that is "fun" for your target audience. If people enjoy it, they will continue to participate. But think out the values carefully.

One stealthy strategic principle keeps showing up in my articles on physics. Have you gradually become aware of it? It is *simplicity*. The idea that the atom *is* the nucleus instead of *has* a nucleus can make atomic physics a lot simpler conceptually. (See [An Atom or a Nucleus?](#)) Have you ever wondered why and how gravity operates? The best scientific minds have tried unsuccessfully to explain the origins of gravitation for hundreds of years. But the answer is startlingly simple and liberating. (See [Advanced Stellar Propulsion Systems](#)) Simplicity is very useful in our society and propagates very well. Eventually, I hope to present ideas that will substantially simplify heavily

mathematical and "conceptually impossible" branches of physics like quantum mechanics. And you can be sure I will have fun doing it!

I am convinced that there is a need for my efforts and insights in this narrow field. George Gamow, a noted physicist, contrasted the startling progress in physics during the first three decades of this century with progress during the next three decades:

"We are still waiting for a breakthrough in the solid wall of difficulties which prevent us from understanding the very existence of elementary particles, their masses, charges, magnetic moments, and interactions. There is hardly any doubt that when such a breakthrough is achieved, it will involve concepts that will be as different from those of today as today's concepts are different from those of classical physics. . . .

After the thirty fat years in the beginning of the present century, we are now dragging through the lean and infertile years, and looking for better luck in the years to come. . . . In spite of all the efforts of the old-timers . . . theoretical physics has made very little progress during the last three decades, as compared with the three previous decades. . . . Let us hope that in a decade or two, or at least, just before the beginning of the twenty first-century, the present meager years of theoretical physics will come to an end in a burst of entirely new revolutionary ideas similar to those which heralded the beginning of the twentieth century." (*Thirty Years that Shook Physics*, Dr. George Gamow, 1966, pp. 4-5, 162-163; 155)

The ingredients for that revolution in physics are now at hand. And lest our knowledge of physics outrun the ability of our culture to handle it constructively, we need a revolution in social thought to go with it!

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Addendum

Seeing Red: Redshifts, Cosmology and Academic Science (Halton Arp, 1998)

This is a new book by Dr. Halton Arp, a maverick professional astronomer who has for decades been pointing out glaring inconsistencies and problems with the current theories of institutional astronomy and astrophysics. Arp received his bachelors degree from Harvard College in 1949 and his Ph. D. from the California Institute of Technology in 1953, both cum laude. He states one of the major aims of this book: ". . . one must fundamentally change the structure of academic science. Communication must be directly to fellow researchers and the public with no possibility of censorship. This is the major aim of this book." (p. 245)

And true to his purpose, the book is full data from astronomy that will turn the current paradigms upside down. It also has a lot of quotables about Academia. Watch for the theme of Negative Knowledge in the following excerpts (which are by no means exhaustive):

"The current beliefs are the crowning achievement of our research and learning institutions, and if they are so completely wrong—and have been for so long in the face of glaring evidence to the contrary—then we must consider whether there has been an overwhelming breakdown in our academic system. If so, we must find out what went wrong and whether it is possible to fix it." (p. 2)

"Scientists, particularly at the most prestigious institutions, regularly suppress and ridicule findings which contradict their current theories and assumptions. . . . astronomers now feel compelled to fit the observations to the theory and not *vice versa*" (p. 12)

". . . it is a clear case of falsifying data for personal advantage—a violation of the primary ethic of science." (p. 15)

"As we will have occasion to mention a number of times during this book, amateurs have a much better grasp of the realities of astronomy because they really *look* at pictures of galaxies and stars. Professionals start out with a theory and only see those details which can be interpreted in terms of that theory." (p. 23)

"The reason we have not had any useful progress is that astronomers don't even look at their own observations." (p. 282; see also 135, 239, 246)

"I thought it would be routine to publish in the journal which was carrying most of the European X-ray results of archival value. How wrong I was! The referee's report came back accusing me of "manipulating the data" and trying to claim an association of quasars with galaxies, which has "long ago been disproved." The editor forwarded these comments and rejected the paper on the ground that he saw no need to reopen the debate. The extraordinary aspect was that four papers in addition to my own had just appeared in the same journal giving strong additional evidence for just such associations! The figures appear here [in Arp's book] for the first time, and the tabular X-ray data is still unpublished." (p. 47)

"I gloomily came to the ironic conclusion that *if you take a highly intelligent person and give them the best possible, elite education, then you will most likely wind up with an academic who is completely impervious to reality.*" (p. 131)

"Jubilation that the paper was finally published has to be tempered with the cold experience that much fewer than 1/3 of the referees in this field are objective." (p. 83)

"Refereeing, or "peer review" as it is rather pompously called, is now unworkable. It has increasingly shown that it lets in the bad papers and excludes the good ones, exactly the opposite of what it is supposed to do. . . . Many reports read like an emotional session of psychotherapy—manipulative, sly, insulting, arrogant and above all *angry*. A sample of these should be published because it would allow people to evaluate the objectivity of the information they are being allowed to read. Their best use would be to enliven the ends of controversial articles with short replies from the authors." (p. 270, 271; see also 47, 83, 19, 101, 244)

"*Astrophysical Journal Letters* is the normal journal for publishing new observations from the Hubble Space Telescope. The telescope cost billions of dollars of public funds. The vast majority of page charges which pay for the publication of the journal come from government supported contracts. The overriding, first directive of the editor is to communicate important new astronomical results. If the editorial process violates its primary responsibility, it misuses public funds." (p. 175)

"*Everyone must make up their own mind on the basis of the evidence and the experts should not be allowed to control the presentation.*" (p. 274)

"The mission of academia should be to explore—not to perpetuate myth and superstition." (p. 257)

"Investigative journalism so far as science is concerned is clearly dead in the water." (p. 260)

". . . it is well justified today that people view institutional claims with skepticism and even hostility. And it is important to always keep in mind who have the vested interests and what they have to gain. (p. 261)

"When I was faced with a directive to renounce observations of new phenomena, I chose early retirement." (p. 275)

"If the data is hijacked at the last moment by a group with a need to control beliefs, the whole enterprise is a failure. (p. 275)

"One lesson from all of this, which seems obvious, is that scientists have to be absolutely honest and straightforward with the public, the people who are paying their salary. Their primary moral obligation is to report the facts and make available a range of interpretations. They have no paternalistic excuse to guard the public from "misunderstandings" or "alarm." If they cannot explain a matter so that a non-specialist can understand it, they don't understand it themselves and they should not cover up this important situation." (p. 266)

Please re-read the last couple of citations and then compare them with this one that I found in the Perspectives section of the Scottsdale Tribune:

"To assert that a supposed process whose very origins, and whose fundamental mechanisms, remain the subject of intense speculation by the brightest minds of science is an established,

incontrovertible fact—and to then dismiss the legitimate questions that assertion raises—is not education. It is indoctrination."

It might come as a surprise, but this is a quote from an article about human evolution, not astronomy ("Evolution's Holy Grail grows ever more elusive", by Gary Nelson, in the Scottsdale Tribune, June 18, 2000, page F4). Furthermore, I do not regard the issues raised by either of these writers as unusual. As history has shown *repeatedly*, this is simply the way institutionalized science works. As Arp reflects, "Astronomy is not so much a science as a series of scandals." (p. 64) The same is true about most any other kind of institutionalized science. Overall, it offers a lot that is good, but the good is freely mixed in with a lot of other "science" that is worthless, misleading, and outright destructive to our society. King Solomon described it succinctly: "Fools are put in many high positions." (Ecclesiastes 10:6, *NIV*)

It is our own tax dollars that support the suppression of data and the breakdown of the scientific process. This case hits close to home with me because I live in Arizona, and Arizona is informally known as "the astronomy capital of the world." So when I read the newspaper article about evolution, I whipped off an email thanking the writer, and just for good measure, pointed out that the same kind of problems occur in astronomy. I (of course) pasted Arp's comments about Academia into the email. I also expressed my view that the professional astronomy community ought to be required to answer all of Arp's serious charges or face cuts in public funding. People who are doing this kind of damage to science should not be allowed to play with such expensive toys, nor have a tax supported forum to infect the public with such blatant rubbish!

If these charges ever see newsprint, I am sure the high priests of the reigning paradigm will respond with another blast of **DOGMA**, all carefully worded to please and reassure the ignorant public, who are expected to do the prescribed number of genuflections during their apologetic retreat. But once alerted, the public is not so easily fooled. And as Arp points out, experienced amateur astronomers can see right through this kind of scam *because they look at the evidence*. And I am sure there are professional astronomers who, like Arp, will speak their minds about the suppressive environment and the childish innuendos made by "professionals" on refereed papers.

"Fools are put in many high positions"
Ecclesiastes 10:6

"The wisdom of this world is foolishness before God"
1 Corinthians 3:19

". . .and men loved the darkness rather than the light; for their deeds were evil.
For everyone who does evil hates the light, and does not come to the light,
lest his deeds should be exposed. But he who practices the truth comes to the light,
that his deeds may be manifested as having been wrought in God."
John 3:19-21

But to me, *Seeing Red* is about much more than the troubles endemic to institutionalized science. This book, and Arp's previous book (*Quasars, Redshifts, and Controversies*, 1987) have helped me a great deal in understanding the meaning of statements in the Bible about how the heavens "wear out like a garment." This was discussed briefly in the Advanced Atomic Energy Converters article (above) in connection with active galaxies and neutrinos. Much more can be said about this now and I hope to eventually write something on this most fascinating topic.

Afternote:

The short excerpt below has some suggestions from the lessons learned at Texas A&M during the “Cold Fusion” controversy several years ago. The article is : ACCOUNTABILITY AND ACADEMIC FREEDOM, The Battle Concerning Research on Cold Fusion at Texas A&M University by J. O’M. Bockris, <http://newenergytimes.com/v2/sr/taubesfabrication/Bockris-AccountabilityAndAcademicFreedom.shtml> :

DECISIONS ON RESEARCH FUNDING

Apart from Anonymity as a New Principle in the decision on funding, there should be a percent of all research funds which are reserved for out of the paradigm (i.e., really original) research proposals. . . . Fundamental research can only be done if government funds are given. At present there is no mechanism by which ideas which are regarded as impossible on the (always temporary) theories of the day can be funded.¹³

HOW TO DECIDE THE VALIDITY OF “ANOMALOUS FINDINGS?”

At present the attitude towards paradigm-inconsistent findings is automatically to reject them, with anger, insisting that they are due to sloppy experiments or fraud. That is dangerous, for it may keep alive a horse which should be led out to pasture. Science is a changing, developing body. The key to progress is to find experimental anomalies to the present view and investigate them How to prove that anomalous findings are not indeed experimental trash? One has immediately to fund two independent investigations to find out! To obtain absolute independence one should keep the identity of the two groups hidden from each other and perhaps one group should be in another country (research costs in Russia (bloated with an excess of scientists) are a small fraction of those here).

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Suppression of the Scientific Process

"Any contradiction between a particular scientific notion and the facts of experience will be explained by other scientific notions; there is a ready reserve of possible scientific hypotheses available to explain any conceivable event. Secured by its circularity and defended further by its epicyclical reserves, science may deny, or at least cast aside as of no scientific interest, whole ranges of experience which to the unscientific mind appear both massive and vital. . . . Scientists were satisfied with speaking of the 'anomalies of strong electrolytes', without doubting for a moment their behavior was in fact governed by the law that they failed to obey. . . . Contradictions to current scientific conceptions are often disposed of by calling them 'anomalies'; this is the handiest assumption in the epicyclical reserve of any theory." (*Personal Knowledge*, Michael Polanyi, 1962, p. 293)

‘Science today is locked into paradigms. Every avenue is blocked by beliefs that are wrong, and if you try to get anything published by a journal today, you will run up against a paradigm, and the editors will turn it down.’ (A quote from Sir Fred Hoyle in Horgan, J., 1995, Profile: Fred Hoyle. *Scientific American* 272(3):24–25.)

"But in current mainstream science, the opposite occurs with disturbing regularity. Anomalous evidence is first ignored, then ridiculed, and if that fails, its author attacked. Scientific conferences will not admit it to be presented, scientific journals will refuse to publish it, and fellow scientists know better than to express solidarity with an unorthodox colleague. In today's scientific world, the cards are just stacked too heavily against true scientific breakthroughs. Too many careers are at stake, too many vested interests are involved for any truly revolutionary advancement in science to take place any more. All too often, scientific truth is determined by the authority of experts and textbooks, not by logic and reason." ("The Suppression of Inconvenient Facts in Physics", Rochus Börner, Ph.D., (2004) http://www.world-mysteries.com/sci_supr.htm <http://inthesenewtimes.com/2010/10/05/the-suppression-of-inconvenient-facts-in-physics/>

“. . . medical, economic, and business-management researchers themselves have studied the reliability of published research and concluded that most of it is flawed, exaggerated, or just plain wrong. No wonder: scientists and other top-shelf experts are often highly biased, shockingly sloppy, and in a surprising number of cases outright frauds—and I'm relying on formal studies of these problems when I make these claims. Medical researchers, for example, have noted that about two thirds of the findings published in top medical journals end up being contradicted. . . . When economists looked at a range of papers published in major economics journals a while ago, they estimated that the wrongness rate of the findings was essentially 100 percent. . . . Surveys of these fields reveal that fraud, careerism, mismeasurement, suppression of data, lousy analysis, politics, poor self-policing, and many other serious shortcomings are fairly widespread even among the most respected researchers and institutions.” (“The Case Against Experts Why advice from the pros can leave us hanging.”, David H. Freedman, June 24, 2010, <http://www.newsweek.com/2010/06/24/the-case-against-experts.html>)

"First, the facts show, I think beyond question, that the traditional proud claim of Science that it acknowledges the absolute authority of experience (i.e. observation and experiment) and reason over all theories, hypotheses, prejudices, expectations or probabilities, however apparently firmly established, can no longer be upheld. The devotion to truth at all costs has gradually given place — largely unconsciously, I believe, but still undeniably — to the blind pursuit of the superficially plausible; the direction towards the most seductive, in which advance has been easiest, has been taken without regard to preservation of contact with the base, which is the truth of experience and reason; the verdict of those authorities falls on deaf ears . . . mathematics has been transformed from the servant of experience into its master, and instead of enabling the full implications and potentialities of the facts of experience to be realised and amplified, it has been held necessarily to symbolise truths which are in fact) sheer impossibilities but are presented to the layman as discoveries) which, though they appear to him absurd, are nevertheless true because mathematical inventions, which he cannot understand require them. The situation is precisely equivalent to that in which the zoologist assured the astonished spectator of the giraffe that if he understood anatomy he would know that such a creature was impossible — except that, in physical science, the layman usually believes what he is told and, unless he is enlightened in time, will be the victim of the

consequences. . . . It is ironical that, in the very field in which Science has claimed superiority to Theology, for example — in the abandoning of dogma and the granting of absolute freedom to criticism — the positions are now reversed. Science will not tolerate criticism of special relativity, while Theology talks freely about the death of God, religionless Christianity, and so on (on which I make no comment whatever). Unless scientists can be awakened to the situation into which they have lapsed, the future of science and civilisation is black indeed." (*Science At the Crossroads* , Herbert Dingle (1972) p.4-5 http://blog.hasslberger.com/Dingle_SCIENCE_at_the_Crossroads.pdf)

"This book is dedicated to a large audience of researchers: scientists, engineers, professors and students wise enough to keep a critical look whenever confronted to the chilling dogmas of contemporary physics. . . . After decades of work, the author is intimately convinced that we have not even began to touch upon the surface of things, nor even began to unveil the true secrets of Nature. To put it more plainly: everything has to be started all over again. Indeed, a number of well known physicists criticized certain aspects of contemporary physics. The great majority of their criticisms has systematically been silenced by some sort of censorship system empowered, if not institutionalized, within the scientific community itself. This statement may surprise those of the readers who still ignore how the system of anonymous referees, as it is being used by scientific journal and magazines, operates and negates every attempt to dismiss or criticise today's mainstream physics and models." (*Advanced Electromagnetism and Vacuum Physics*, Patrick Cornille (2003) p. 1)

"American and British history is riddled with examples of valid research and inventions which have been suppressed and derogated by the conventional science community. This has been of great cost to society and to individual scientists. Rather than furthering the pursuit of new scientific frontiers, the structure of British and American scientific institutions leads to conformity and furthers consensus-seeking." ("Cognitive Processes and the Suppression of Sound Scientific Ideas" J. Sacherman (1997) <http://amasci.com/suppress1.html>)

"For several centuries, modern science was pretty much a free intellectual market populated by independent entrepreneurs who shared the goal of understanding how the world works. Nowadays it's a corporate enterprise where patents, pay-offs, prestige, and power take priority over getting at the scientific truth, and the powers-that-be have established *knowledge monopolies*." ("Suppression of Science Within Science", Henry Bauer <http://www.lewrockwell.com/orig10/bauer1.1.1.html>)

"Science has seldom lived up to its ideal as an open, disinterested enquiry into nature, as any scientist who has ever tried to publish genuinely new ideas or findings in the 'peer-reviewed' scientific journals will know too well. Nobel Laureate Hans Krebs' discovery of the metabolic cycle that would eventually bear his name was rejected from the journal Nature. . . .

In the course of liberating itself from the Church, the scientific establishment has inherited many of the trappings of fundamentalist religion. There can be but One True Science, and everything else tends to be treated as nonsense or heresy. Within the past 50 years, the suppression of dissent has plumbed new depths, as the scientific establishment is increasingly getting into bed with big business. At first, it was mostly physics and chemistry, now it is pre-eminently biology. And as corporations are growing bigger and more powerful, so the suppression of scientific dissent is becoming more sophisticated, insidious and extensive. As the scientific and the political mainstream have both come to identify with corporate aims, so their established power structures are brought to bear on squashing scientific dissent and engineering consensus." ("The New Thought Police – Suppressing Dissent in Science", Mae-Wan Ho, Jonathan Mathews <http://www.psrast.org/thoughtpolice.htm>)

"The results of this suppression of creativity are not limited to the world of grant-funded research. The same leadership that fosters the status quo in research also affects the classroom. A university education is supposed to teach students how to think critically. However, that goal has been set aside in many of our classrooms, being traded for the less ambitious goal of memorizing facts. Curiously, when the rote memorization is emphasized, creative students are often penalized. Multiple-choice exams are the standard for testing a student's ability to memorize facts, and creative students are usually not adept at guessing what a test writer is thinking. They are much better at solving problems, generating hypotheses, designing protocols, and developing a deep understanding of their discipline—all key aspects of good critical thinkers and professionals in science. By rewarding those students who accept the current facts as gospel, rather than skills that are likely to lead to the creation of new knowledge, universities are stifling the next generation of scientists." ("Opinion: Academia Suppresses Creativity", Fred Southwick (2012) <http://www.the-scientist.com/?articles.view/articleNo/32077/title/Opinion--Academia-Suppresses-Creativity/>)

"When science's self-correctiveness fails, the cost is enormous because error compounds itself. "Surprising" discoveries are noted, but scientists continue seeking explanations within the frameworks of old models long after those models should have been discarded. This not only leads theoretical science into a deeper and deeper state of crisis, it comes at a significant cost to the taxpayer and is ultimately a betrayal of the public's trust. Models that fail need to be dispelled of, all of the assumptions from which they've arisen must be questioned, and alternatives must be examined, considered and tested." ("Does Science Admit When it's Wrong?", B. Talbott (Nov. 2012) <http://www.thunderbolts.info/wp/2012/11/26/does-science-admit-when-its-wrong/>)

Why too much evidence can be a bad thing

"In a new paper to be published in *The Proceedings of The Royal Society A*, a team of researchers, Lachlan J. Gunn, et al., from Australia and France has further investigated this idea, which they call the "paradox of unanimity." "If many independent witnesses unanimously testify to the identity of a suspect of a crime, we assume they cannot all be wrong," coauthor Derek Abbott, a physicist and

electronic engineer at The University of Adelaide, Australia, told Phys.org. "Unanimity is often assumed to be reliable. However, it turns out that the probability of a large number of people all agreeing is small, so our confidence in unanimity is ill-founded. This 'paradox of unanimity' shows that often we are far less certain than we think." . . . The researchers demonstrated the paradox in the case of a modern-day police line-up, in which witnesses try to identify the suspect out of a line-up of several people. The researchers showed that, as the group of unanimously agreeing witnesses increases, the chance of them being correct decreases until it is no better than a random guess." "Why too much evidence can be a bad thing" <http://phys.org/news/2016-01-evidence-bad.html>

"An astonishing two-thirds of all biomedical and life-science research publications and research articles that have been retracted from the public domain have been retracted because of fraud." ("An Alarming Two Thirds of All Scientific Publications and Research Retracted Found to Be Fraudulent", Andrew Puhanic (2012) <http://www.theglobalistreport.com/publications-research-articles-retracted-fraud/> <http://www.theglobalistreport.com/wp-content/uploads/2012/10/PNAS-2012-Fang-1212247109.pdf>

"Study: Fraud growing in scientific research papers", Seth Borenstein (Oct 2012) <http://news.yahoo.com/study-fraud-growing-scientific-research-papers-190641079.html>

"'Awash in False Findings' Is most scientific research factually distorted?", Trevor Butterworth (Feb 2013) <http://www.thedailybeast.com/newsweek/2013/02/25/new-research-claims-science-is-awash-in-false-findings.html> <http://www.nature.com/news/define-misconduct-as-distorted-reporting-1.12411>

"Scientists' Elusive Goal: Reproducing Study Results", Gautam Naik (Dec 2011) *Wall Street Journal* <http://online.wsj.com/article/SB10001424052970203764804577059841672541590.html>

"FDA: Failure, Deception, Abuse: The Story of an Out-of-Control Government Agency and What It Means for Your Health", Life Extension Foundation (2010) <http://www.amazon.com/FDA-Deception-Out-Control-Government/dp/1607660016>

"Strong Medicine", Reader's Digest, April 2008, p. 118-131 <http://newstrain.com/2008/10/02/strong-medicine-whats-ailing-the-fda/>

"Science Casts Doubt on FBI's Bullet Evidence" (2003) <http://cironline.org/reports/science-casts-doubt-fbis-bullet-evidence-1860>

"Study: FBI Bullet Tests Seriously Flawed", (2003) <http://www.freerepublic.com/focus/f-news/1026703/posts>

"High-Risk Forensics", Osagie K. Obasogie (2013) <http://www.nytimes.com/2013/07/25/opinion/high-tech-high-risk-forensics.html>

History of the Warfare of Science with Theology in Christendom, Andrew Dickson White, 1895, "From Magic to Chemistry and Physics" (chapter 12) <http://human-nature.com/reason/white/chap12.html>

Making Sense of Medicine, <http://www.msomed.org/>

"Oops! US Doctors Screw Up Surprisingly Often: Study", Tia Ghose (2012) <http://news.yahoo.com/oops-us-doctors-screw-surprisingly-often-study-195455440.html>

"High Cholesterol: New Strategy for an Old Battle", Life Extension Magazine, Silas Hoffman, (November 2012) p.87-93

"Scientific misconduct" http://en.wikipedia.org/wiki/Scientific_misconduct

"Ben Stein Roused By Suppression In Science", Diana deRegnier (2008) http://www.science20.com/spiritlinks/ben_stein_roused_suppression_science-8408

"Suppression of dissent in science", Brian Martin (1999) <http://www.bmartin.cc/pubs/99rsppp.html>

"When "Science" Serves Suppression" <http://www.enterprisemission.com/suppression.htm>

"Referee Recommendations", Ivo Welch (2012) http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2137119

"Eight Traits of the Disinformationalist" <http://beforeitsnews.com/alternative/2013/06/eight-traits-of-the-disinformationalist-2674228.html>

"Scientific world getting duped by computerized fake research papers", Erik Sherman, *MoneyWatch* (February 27, 2014) <http://www.cbsnews.com/news/computerized-fake-research-papers-get-published/>

"The myth of 'settled science'", Charles Krauthammer (2-20-2014) "There is nothing more anti-scientific than the very idea that science is settled, static, impervious to challenge." http://www.washingtonpost.com/opinions/charles-krauthammer-the-myth-of-settled-science/2014/02/20/c1f8d994-9a75-11e3-b931-0204122c514b_story.html

"How Government treated Those For Whom We Now Celebrate Holidays" *Life Extension Magazine*, Vol.20, No. 3 (March 2014) pp. 7-12 <http://www.lef.org/Health-Wellness/LECMS/Zmags.aspx?pid=a0f192fd&source=CVC400E>

"When Technology Goes *In Reverse*" *LifeExtension Magazine*, Vol.20, No. 3 (March 2014) pp. 22-28 <http://viewer.zmags.com/publication/a0f192fd#/a0f192fd/24>

"Peer review could reject breakthrough manuscripts, study shows", Marcia Malory (Dec 23, 2014) <http://phys.org/news/2014-12-peer-breakthrough-manuscripts.html>

" '97% Of Climate Scientists Agree' Is 100% Wrong", <http://www.forbes.com/sites/alexepstein/2015/01/06/97-of-climate-scientists-agree-is-100-wrong/2/>

" "A lot of what is published is incorrect." I'm not allowed to say who made this remark because we were asked to observe Chatham House rules. . . .this symposium—on the reproducibility and reliability of biomedical research, held at the Wellcome Trust in London last week—touched on one of the most sensitive issues in science today: the idea that something has gone fundamentally wrong with one of our greatest human creations."

"The case against science is straightforward: much of the scientific literature, perhaps half, may simply be untrue. Science has taken a turn toward darkness." - (Richard Horton, editor in chief in the April 15th, 2015 edition of Lancet[http://www.thelancet.com/journals/lancet/article/PIIS0140-6736\(15\)60696-1/fulltext](http://www.thelancet.com/journals/lancet/article/PIIS0140-6736(15)60696-1/fulltext) <http://www.tumblr.com/search/research%20fraud>)

"One reason so many scientific studies may be wrong", Geoff Cumming (2016) (regarding p-hacking) <http://phys.org/news/2016-10-scientific-wrong.html>

An Exercise

First, consider a few offhand rules for population management and control used by governments:

1. **Keep them fearful.** The government knows what is really going on. AND ITS REALLY BAD! Only the government can protect you from the boogeymen. Don't listen to those other guys. They are well-meaning but misinformed people. They just don't know any better. Or maybe they are drunk, popping LSD, smoking pot, etc.
2. **Keep them ignorant.** Don't give them the information they need to make informed decisions, or even hint that such information exists. Tell them how to influence people by using emotion instead of facts, reason, and logic. Don't address the issues. Point out who is right, who is wrong, who is smart, who is stupid, who is wise, who is a crackpot. After all, it is all about PEOPLE isn't it? Add plenty of snarky wisecracks, insults and name-calling. Call it a "true science forum".
3. **Keep them confused.** Have the experts offer differing and contradictory opinions. What is "incontrovertible truth" today (that any REASONABLE person would accept) is "false" or "outdated" tomorrow.
4. **Keep them distracted.** Give them "bread and circus" like the Romans did. "News" is who won the football game or what moviestar is wearing a different colored bra.

Now read about some unfamiliar, emotionally loaded issue, preferably one that you may already have a vague opinion about. I suggest:

Marijuana and Opium

"A Brief History of the Drug War", <http://www.drugpolicy.org/new-solutions-drug-policy/brief-history-drug-war>
(Nixon's war on drugs and its ugly legacy)

"The True History of Marijuana" <http://www.wakingtimes.com/2015/03/07/history-of-cannabis-and-the-truth-behind-its-prohibition/>

<http://www.wakingtimes.com/2014/05/08/debunking-the-5-biggest-myths-about-cannabis/>

"The Culture High" (2014) --a video documentary recommended by readers.

"Cannabinoids as antioxidants and neuroprotectants" <http://www.freepatentsonline.com/6630507.pdf> :

Abstract: Cannabinoids have been found to have antioxidant properties, unrelated to NMDA receptor antagonism. This new found property makes cannabinoids useful in the treatment and prophylaxis of wide variety of oxidation associated diseases, such as ischemic, age-related, inflammatory and autoimmune diseases. The cannabinoids are found to have particular application as neuroprotectants, for example in limiting neurological damage following ischemic insults, such as stroke and trauma, or in the treatment of neurodegenerative diseases, such as Alzheimer's disease, Parkinson's disease and HIV dementia. Nonpsychoactive cannabinoids, such as cannabidiol, are particularly advantageous to use because they avoid toxicity that is encountered with psychoactive cannabinoids at high doses useful in the method of the present invention.

Assignee: The United States of America as represented by the Department of Health and Human Services (Washington, DC)

See also:

"Use of cannabinoids as anti-inflammatory agents" [United States Patent 6410588](http://www.cbsnews.com/news/4-americans-get-medical-pot-from-the-feds/)
<http://www.cbsnews.com/news/4-americans-get-medical-pot-from-the-feds/>
<http://www.medicalcannabis.com/cannabis-science/safety-profile/chronic-use-study/>
<http://www.wakingtimes.com/2014/04/07/meet-us-governments-number-one-medical-cannabis-recipient/>

Opium for the Masses: Harvesting Nature's Best Pain Medication, Jim Hogshire
(2009) <http://www.amazon.com/Opium-Masses-Harvesting-Natures-Medication/dp/1932595465>

Vaccines, autism, and related concerns

What the public does NOT read:

"Abnormal measles-mumps-rubella antibodies and CNS autoimmunity in children with autism", *J Biomed Sci.* 2002 Jul-Aug;9(4):359-64. <http://www.ncbi.nlm.nih.gov/pubmed/12145534>

"Serological association of measles virus and human herpes virus-6 with brain auto-antibodies in autism", *Clin Immunol Immunopathol.* 1998 Oct;89(1):105-8. <http://www.ncbi.nlm.nih.gov/pubmed/9756729>

"Hypothesis: conjugate vaccines may predispose children to autism spectrum disorders", Med Hypotheses. 2011 Dec;77(6):940-7. doi: 10.1016/j.mehy.2011.08.019. Epub 2011 Oct
10. <http://www.ncbi.nlm.nih.gov/pubmed/21993250>

"Hepatitis B vaccination of male neonates and autism diagnosis, NHIS1997-2002", J Toxicol Environ Health A. 2010;73(24):1665-77. doi: 10.1080/15287394.2010.519317. <http://www.ncbi.nlm.nih.gov/pubmed/21058170>

"Immunological findings in autism", Int Rev Neurobiol. 2005;71:317-41. <http://www.ncbi.nlm.nih.gov/pubmed/16512356>

"Do aluminum vaccine adjuvants contribute to the rising prevalence of autism?", J Inorg Biochem. 2011 Nov;105(11):1489-99. doi: 10.1016/j.jinorgbio.2011.08.008. Epub 2011 Aug
23. <http://www.ncbi.nlm.nih.gov/pubmed/22099159>

"Aluminum Vaccine Adjuvants: Are they Safe?", Curr Med Chem. 2011;18(17):2630-7. <http://www.ncbi.nlm.nih.gov/pubmed/21568886>

"Biopersistence and brain translocation of aluminum adjuvants of vaccines." <http://www.ncbi.nlm.nih.gov/pubmed/25699008>

<https://www.youtube.com/watch?v=jsDKP9rXLkg&feature=youtu.be&t=42m44s> (consequential effects of aluminum in vaccines)

"Autoimmune/inflammatory syndrome induced by adjuvants (Shoenfeld's syndrome): clinical and immunological spectrum." Expert Rev Clin Immunol. 2013 Apr;9(4):361-73. doi: 10.1586/eci.13.2. <http://www.ncbi.nlm.nih.gov/pubmed/23557271>

"Long-term Persistence of Vaccine-Derived Aluminum Hydroxide is Associated with Chronic Cognitive Dysfunction.", J. Inorganic Biochemistry Volume 103, Issue 11, November 2009, Pages 1571–1578
<http://www.sciencedirect.com/science/article/pii/S0162013409001895>

"Neurodevelopmental disorders following thimerosal-containing childhood immunizations: a follow-up analysis." Int J Toxicol. 2004 Nov-Dec;23(6):369-76. <http://www.ncbi.nlm.nih.gov/pubmed/15764492>

"Administration of thimerosal to infant rats increases overflow of glutamate and aspartate in the prefrontal cortex: protective role of dehydroepiandrosterone sulfate." <http://www.ncbi.nlm.nih.gov/pubmed/22015977>

The Peanut Allergy Epidemic: What's Causing It and How to Stop It (June 2011) by Heather Fraser (peanut oil is used in making vaccines)

Narcolepsy and H1N1 vaccine in

Europe: http://www.cdc.gov/vaccinesafety/Concerns/h1n1_narcolepsy_pandemrix.html ; <http://en.wikipedia.org/wiki/Pandemrix> ; <http://blogs.nature.com/news/2014/07/journal-retracts-paper-linking-vaccine-and-narcolepsy.html>

"Acellular pertussis vaccination enhances B. parapertussis colonization", synopsis by Alexia Karanikas <http://www.cidd.psu.edu/research/synopses/acellular-vaccine-enhancement-b.-parapertussis> ;
(<http://www.biomedcentral.com/1741-7015/13/146>)

"In contrast, vaccination led to a 40-fold enhancement of B. parapertussis colonization in the lungs of mice. Though the mechanism behind this increased colonization was not specifically elucidated, it is speculated to involve specific immune responses skewed or dampened by the acellular vaccine, including cytokine and antibody production during infection. Despite this vaccine being hugely effective against B. pertussis, which was once the primary childhood killer, these data suggest that the vaccine may be contributing to the observed rise in whooping cough incidence over the last decade by promoting B. parapertussis infection. Highlighting the extreme consideration that should be exercised in future vaccine development, this work supports the use of vaccines that also target B. parapertussis as a potentially more efficient way to battle whooping cough. "

<http://www.supremecourt.gov/opinions/10pdf/09-152.pdf> " the Act eliminates manufacturer liability for a vaccine's unavoidable, adverse side effects"

What the public DOES read:

<http://www.vaccinateyourbaby.org/safe/autism/mmr.cfm>

<http://www.forbes.com/sites/brucejapsen/2015/06/08/ama-end-personal-religious-vaccination-exemptions/>

Straight-faced lies in congressional testimony by CDC official (Dr. Anne Schuchat) about vaccines and autism. Compare the content of the above abstracts from accredited, peer reviewed journals with the testimony shown in this video: <http://youtu.be/k9XRbjOQDvY?t=72>



"CDC Whistle Blower admits MMR Vaccine causes Autism", https://www.youtube.com/watch?v=q62DcaNs_0M

"CDC Whistleblower Discloses Deception", <https://www.youtube.com/watch?v=qxr-cv-JuI8>

"Obama Grants Immunity to CDC Whistleblower on Measles Vaccine Link to Autism"
, <http://healthimpactnews.com/2015/obama-grants-immunity-to-cdc-whistleblower-on-measles-vaccine-link-to-autism/>

"Congress hears testimony of CDC scientist admitting cover up of vaccine autism links in black boys"

<http://www.sott.net/article/299585-Congress-hears-testimony-of-CDC-scientist-admitting-cover-up-of-vaccine-autism-links-in-black-boys>
<http://www.sott.net/article/284578-CDC-vaccine-fraud-340-risk-of-autism-hidden-from-public>

Did you notice any of these rules silently operating in the free and open society of the United States of America?

Other:

<http://www.wakingtimes.com/2015/04/29/the-operation-called-engineered-consensus/>

Non-Mainstream Views of Astronomy and Astrophysics

[Beyond Einstein: non-local physics](#) by Brian Fraser (2015) Corrects some misconceptions about Special and General Relativity. SR and GR are specifically "local" theories and cannot adequately treat "non-local" phenomena.

"The Michelson-Morley experiment of 1887 . . . actually did not give the result required by relativity! It admittedly substantiated its authors' claim that the relative motion of the earth and the 'ether' did not exceed a quarter of the earth's orbital velocity. But the actually observed effect was not negligible; or has, at any rate, not been proved negligible up to this day. The presence of a positive effect . . . was pointed out . . . as corresponding to an 'ether-drift' of eight to nine kilometres per second. Moreover, an effect of the same magnitude was reproduced by D. C. Miller and his collaborators in a long series of experiments extending from 1902 to 1926, in which they repeated the Michelson-Morley experiment with new, more accurate apparatus, many thousands of times. . . . The experience of D. C. Miller demonstrates quite plainly the hollowness of the assertion that science is simply based on experiments which anybody can repeat at will." [i.e.: the experiment was repeated but "science" simply ignored the result -BF] (*Personal Knowledge*, Michael Polanyi, 1962, p. 12-13)

Dissident View of Relativity Theory by William H. Cantrell, Ph.D.

<http://www.infinite-energy.com/iemagazine/issue59/adissidentview.html>

The Einstein Myths

<http://www.infinite-energy.com/iemagazine/issue38/einstein.html>

<http://www.infinite-energy.com/iemagazine/special>

The Universe of Motion, Dewey B. Larson, 1984

The Reciprocal System, <http://www.rsystem.org>

The Collected works of Dewey B. Larson, <http://www.rsystem.org/dbl/index.htm>

Andromeda and our Milky Way may have been ejected from M87

(this article has not been written and is not scheduled)

"In the beginning God created the heavens and the earth. (Genesis 1:1)

unverified references and possible source material:

- Sky and Telescope:

Arp, Halton:

book review, 55:64.

The Crucial Assumption about Redshifts, 75:42. letter,

70:100;

75:462;

Vol 85 No 2, p. 6;

Vol 87, No 3, p. 9.

On the Origin of Arms in Spiral Galaxies, 38:385.

Related Galaxies with Different Redshifts? 65:307.

Arp, Halton C., and David L. Block, The Myth of Overgrown Spirals, 81:373.

Arp, Halton C., Geoffrey Burbidge, and Adelaide Hewitt, letter, 90:2:9.

Cold Fusion, Remediation of Radioactive Waste, etc

You might also want to read my comments about [Cold Fusion](#).

See also [Brian Fraser's Adventures in Energy Destruction](#) for more insights about a process that can affect radioactive decay rates.

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<http://scripturalphysics.org/4v4a/ADVPWR.html>

Some Thought Provoking Issues

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last modified 4-7-15b

A good theoretical picture can truly light the way for a researcher. It can predict new phenomena and explain known ones. It can assist greatly in implementing a new technology; dead ends can largely be avoided and promising avenues can be explored directly without wasting excessive time, money, or other resources. But new theories, despite their potential usefulness, are often strongly resisted by people who have preconceptions about what is "known to be true" and which they place beyond examination (and if you think scientists have a monopoly on this one, just visit your local church and try discussing some of the ideas in [Make Sure of All Things](#)). People not only acquire beliefs, beliefs can also acquire people. Getting people around these blind spots takes an enormous amount of effort and persistence, as they usually have no interest in being confused with more facts (it is like arguing with the town drunk). One way I try to take the frustration out of this is to offer people ideas that are personally relevant and interesting. If I can make learning fun, they will educate themselves automatically.

You have already seen a few "fun" sections at this site. This is another one, except it is a bit more on the serious side. In the section below, I hope to offer some interesting topics that could benefit from a fuller development of the ideas and concepts that I have outlined here in various articles.

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Potassium Carbonate Electrolysis cells

Hydrogen gas cell (Randell Mills)

Hydrogen gas cell (Les Case)

Patterson Power Cell™

Transmutation / Remediation of radioactive elements

Alternative Technologies

Joseph Papp's Noble Gas Engine

Electroaerodynamics and the Biefeld Brown effect

Conventional Technologies

Directories and publications:

Windspire windmill, <http://www.windspireenergy.com/windspire/photos-and-videos/>

Updates [12-13-01](#), [5-4-02](#), [8-21-02](#), [RFI 12-13-02](#), [2-27-04](#) [11-11-06](#)

Evidence for Equivalence of Thermal Space and Electron Space

Energy from massless particles?

Ray guns, Nuclear Isomers, Rydberg Atoms

Melted volume increases, but internuclear distance decreases. Why? (11-11-03a)

Melted *atoms* or a melted *aggregate*? (1-1-05)

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Cold Fusion, Remediation of Nuclear Waste, etc.

"Cold fusion" came onto the world scene in 1989 with the now famous announcement by Dr. Martin Fleischmann and Dr. Stanley Pons. At first there were doubts about the phenomena they described, but cautious scientific credibility seemed to have been achieved by about 1995. The term "cold fusion" was recognized as a misnomer and alternative terms like "Chemically Assisted Nuclear Reactions", "low-energy nuclear reactions", "electronuclear chemistry", etc. were proposed. The effect is still not very well understood and the topic remains controversial, but the problems of reproducibility are gradually being worked out.

Needless to say, "the institutionalized, atherosclerotic science of the precision mound-builders" ☺ would like to ignore the whole thing. But the political and economic implications of this phenomena were nothing short of stupefying. If atomic energy can be released by a low energy process and with relatively simple, inexpensive equipment, then a source of cheap, non-polluting, robust (high-power) energy becomes readily available to every nation and every person. Such a source could inexpensively light our cities, power our factories, transportation systems, and water treatment plants. It could power our cars, heat and cool our homes, and do many other things that we take for granted nowadays. And if this type of energy could be converted directly into electric energy (like photocells do with light) then airplanes could use powerful and efficient electric motors and never run out of fuel while in flight. The possibilities just seemed endless.

Of course, I was wondering how to view this announcement myself. To me it was inconceivable that these experiments were converting the extremely stable primary mass of the atom into another form. That would normally require energies of hundreds of millions of electron volts or fantastically high temperatures (10^{13} Kelvin). If the effect was real, there must be some other way. In [Advanced Atomic Energy Converters](#) I had presented the concept of "excess mass". I suggested that the "primary mass" of the atom was simply twice the atomic number. The actual mass was simply this amount plus an "excess mass" that had a different character (similar to isotopic mass). If the "cold fusion" experiments were tapping into this "other" kind of mass, the theoretical problems might be circumvented. The article also suggested that heavy elements are built up in interstellar space by a low energy process involving neutrinos. So I began to wonder if the reverse could also be true. Could a low energy process *extract* this energy? The heaviest elements even decay spontaneously. Maybe the lighter, more common ones just needed a special environment.

Most cold fusion experiments use hydrogen in some form (usually water, hydrocarbons, or hydrogen gas). I regarded the element hydrogen as peculiar in that I expected its mass to be 2 amu, but instead it is only 1. In other words, hydrogen has barely made it into the Periodic Table. Could hydrogen be some kind of mediator between fully atomic rotational systems (atoms) and systems that are not fully atomic like the neutrino, or even the photon? (See [Update 12-13-01](#) below.) It did not seem likely that atoms, could in one step, convert a stable, compound rotational system into a much simpler form like the photon. But the conversion of *part* of a compound rotational system into a *massless* rotational system, which then converts to a photon or ordinary linear kinetic energy seemed to be much more likely. And it would be even easier if the isotopic mass had a rotational character that was (somehow) more like the photon than that of the atom.

The section on the [Atomic Spin System](#) in [Intuitive Concepts in Quantum Mechanics](#) shows how the 4π and 2π rotational systems might be incorporated into the atom. The relationship to the double 2π rotational system of the photon is also implied and somewhat suggests how a photon converts to mass and vice versa. The article also attempted to extend the periodicity rules of the Periodic Table "backwards" into the realm of subatomic particles. This produced a couple of families of subatomic particles. Of special interest here is one three-member group that has a neutrino, a stable but massless neutron, and an unnamed particle that is one rotation less than hydrogen, and probably also massless and stable. This raises the following questions:

1. Could this hypothetical massless neutron be a participant in the cold fusion experiments? One accusation leveled against "cold fusion" is that it "does not produce neutrons". Yet it does transmute elements into non-natural elemental abundance ratios. Could a massless neutron be an answer to one part of this puzzle? Such a neutron would not be detectable by conventional neutron counters. Copious quantities of them would probably not have detrimental biological effects either, although this is not known for certain. (Note that massless particles still have a deBroglie wavelength)

<http://www.mwit.ac.th/~Physicslab/hbase/starlog/cygx3.html> : "Intriguing [underground events](#) in the Soudron iron mines in October 1985 included 60 anomalous muon events in a 3° cone around Cygnus X-3 with a precise period of 4.79 hours, so they clearly came from that source. But that requires a neutral particle traveling at almost precisely the speed of light, and there are no reasonable candidates for such a particle. "

2. Could the Unnamed Particle, {1,1,1}, the closest subatomic particle to hydrogen, likewise be involved in cold fusion? Randell Mills of Blacklight Power (<http://www.blacklightpower.com>), for instance, postulates the existence of a "hydrino" and describes it as "lower energy atomic hydrogen" and "smaller-than-normal hydrogen atoms". Interestingly, the Unnamed Particle, whose existence is suggested by "backwards" extension of periodicity, is in the neutrino family, and is only one rotational magnitude below actual hydrogen. The words that Mills uses are pretty close to a decent description. (It is very unusual that two researchers, using very different methods and very different starting points, end up needing what is apparently the same yet-to-be-discovered particle. This definitely needs to be investigated!) See [Update 12-13-01](#) below.

3. The intrinsic spin structure of the excess atomic mass ("isotopes") needs to be elucidated. All that seems to be known at this point is the 4π and 2π spins, and various compound structural combinations thereof. The theoretical picture for isotopic mass needs to support a nature that is somewhat foreign to the basic atomic intrinsic spin system. It could be foreign structurally or foreign in the space/time sense. Ideally, it would be of the sort that shows the properties of mass only when it becomes associated with another rotational system that is already effective in three dimensions (like the atom).

The role that electrons play in these experiments also needs to be investigated. Consider, for example, a 1929 report of a fascinating experiment done by Alfred Coehn, professor of physics at the University at Göttingen, Germany:

"Coehn saturated one end of a palladium wire with hydrogen gas. He found that under the influence of a voltage placed end to end on the wire, the hydrogen inside the wire migrated along the length of the wire." (*Excess Heat: Why Cold Fusion Research Prevailed*, Charles G. Beaudette, 2000, p.32)

This discovery was applied more recently in the cold fusion experiments by Giuliano Preparata:

"Giuliano Preparata presented a report of his new palladium with heavy water electrolyte experiment at the ICCF-6 meeting in October 1996. It is a large volume cell with a fine wire Pd cathode that runs, zig-zag, up and down progressing around the inside the wall of the flask. The platinum anode is located at the center of the cell. What is unique about the experiment is that two power supplies are used to operate it. One is connected to the anode and cathode to drive current through the electrolyte as is conventional. The other is connected to the ends of the cathode wire. During the course of the experiment, it maintains a current along the length of the palladium wire.

This current serves to enable high loading of deuterium into the cathode. The reader will recall that the loading had to be greater than 0.9 ratio of [D/Pd] atoms, and that was difficult to get. Usually, the palladium sample had to be sorted to find those that would "accept" high loading. Preparata uses this second current to obtain high loading. By avoiding the sorting and selection process for palladium, he claims to have obtained 100% reliability in building Fleischmann and Pons types of cells." (*ibid.*, p.207; see also p. 74, 224-225)

Preparata ran about 50 similar experiments and observed the same result. The Preparata device produced a [cathode material] power density of 100,000 watts per cubic centimeter. For comparison, a fuel rod in a nuclear reactor has a power density of about 500 to 1000 watts per cubic centimeter. (*ibid.* p. 256-257)

It is well known that hydrogen can diffuse into metals like palladium, titanium, nickel, and others. It is also obvious that hydrogen can diffuse into empty, open space. When matter moves through open space, its energy of motion is described mathematically as $KE = \frac{1}{2}mv^2$. What is probably not so obvious is that space can move through matter, and that its energy of motion is described by an equation of the same form, $U_L = \frac{1}{2}Li^2$, because it is exactly analogous to motion of matter in space. *This* kind of space has to be rotational, rather than linear, however. That means it acts like a particle (an electron) and can be moved around inside a wire under the influence of an electric field, a phenomenon commonly known as electric current.

In the Preparata device, deuterium at first migrates into the palladium, but as the palladium loads up, the deuterium has an increasing probability of migrating back out. The presence of the "electron space" apparently changes all this. The electron motion may have the effect of sweeping the deuterium off the inner surface of the palladium, and of distributing it more uniformly throughout the bulk of the material. Very high current densities are required however. (<http://www.altenergy.org/4/iccf8/day2/day2.html>)

Electrolytic cells can also be used to transmute elements. My impression from reading the literature is that transmutations may be occurring in anything that could broadly and loosely be called "an electrolytic process" particularly when run at high current densities, and higher than normal temperatures and pressures, and with or without electrodes that can absorb hydrogen. Electrolytic cells usually run on direct current but they could probably also run on alternating current and still produce transmutations. The transmutation effect might be just as common as electrode sludge. "Expensive-to-worthless" transmutations should be relatively easy. I would expect that heavy elements would convert to lighter ones, and radioactive elements to non-radioactive ones.

The latter point is especially worth investigating. An ordinary 1000 megawatt nuclear reactor will produce in one year an amount of strontium 90 equivalent to the radioactivity of 3000 kilograms of radium (3×10^6 Curies; one Curie is 3.7×10^{10} decays/sec). Storage of such a dangerous substance is expensive and its long term safety will always be questionable. Neutralization on site is far preferable to storage. (see

also <http://geocities.com/rainforest/andes/6180/waste.html>)

So electrons, as particles "less-than-atomic", do play a role in these cases. And electrons are present in matter even if not in the form of a current. It is possible that they may somehow participate directly in the conversion of isotopic mass to energy.

There is an overwhelming amount of information on the Internet about cold fusion. Many original papers can be found at:

<http://lenr-canr.org/>

<http://www.infinite-energy.com>

<http://www.newenergytimes.com>

<http://iscmns.org>

<http://www.world.std.com/~mica/cft.html> (*Cold Fusion Times*)

<http://www.cbsnews.com/stories/2009/04/17/60minutes/main4952167.shtml> "Cold Fusion is Hot Again", April 19, 2009

[Science of Low Energy Nuclear Reaction: A Comprehensive Compilation of Evidence and Explanations about Cold Fusion](#)

<http://www.std.com/~mica/jetrefs.htm> (refs. to M. Swartz papers)

For those who want a thumbnail sketch of a few interesting ideas, I would suggest browsing the following links (please keep in mind my interests here are theoretical, not commercial):

"Excess" hydrogen from electrolysis

There are many reports of hydrogen generation from electrolysis of water that are in excess of the Faraday equivalent. The effect is not well understood, but it has become very difficult to dismiss these reports as "junk science". Reports of "anomalous production of hydrogen" even go back to the 1950s. Hydrogen is an important industrial chemical. It is used large scale in the refining of petroleum, production of ammonia, and reduction of metal oxides to actual metals. It can also be used as a very clean, easily renewable energy source.

<http://www.lenr-canr.org/acrobat/MizunoTconfirmatib.pdf> Mizuno, T., T. Akimoto, and T. Ohmori. "Confirmation of anomalous hydrogen generation by plasma electrolysis in 4th Meeting of Japan CF Research Society". 2003. Iwate, Japan: Iwate University

"Continuous generation of hydrogen above levels predicted by Faraday's law is observed when temperature, current density, input voltage and electrode surface meet certain conditions. Although only a few observations of excess hydrogen gas production have been made, production is sometimes 80 times higher than normal Faradic electrolysis gas production. " See also <http://www.lenr-canr.org/acrobat/MizunoTgeneration.pdf>

<http://jlnlabs.free.fr/cfr/html/cfrdatas.htm>

"I have replicated successfully the Mizuno-Ohmori's Cold Fusion experiment. I have used the experimental protocol fully described by Eugene F. Mallove at : <http://www.amasci.com/weird/anode.txt> " ". . . fully replicable and that it works very well as described in their papers." (See also <http://jlnlabs.free.fr/cfr/ppclkr/index.htm>)

<http://www.panacea-bocaf.org/kanarevelectrolysis.htm>

"Professor Kanarev has shown a new form of electrochemistry which can generate much more hydrogen than a conventional electrolysis ever could. His tests show at least 10 times the capacity but his data also suggests 4,000 times more hydrogen than the Wh input would predict. He also has measured very significant hydrogen generation when his cell is not powered."

<http://guns.connect.fi/innoplaza/energy/story/Kanarev/coldfusion/>

"It is known that from one litre of water it is possible to produce 1220 litres of hydrogen and 622 litres of oxygen. Quantity of the gases generated by the plasma electrolytic process is much greater than it is possible to get from consumed water (Table 1) [6]. It gives the reason to think that not only water molecules, but the nuclei of alkaline metals and the atomic nuclei of the cathode material serve as a source of these gases. . . ."

"Thus, the hypothesis concerning the participation of the nuclei of alkaline metals and the atomic nuclei of the cathode material in the formation of gases during plasma electrolysis of water has experimental confirmation."

<http://guns.connect.fi/innoplaza/energy/story/Kanarev/index.html>

<http://guns.connect.fi/innoplaza/energy/story/Kanarev/video/VIDEOELECTROLYS.wmv>

<http://www.jproeng.com/qikan/manage/wenzhang/206517.pdf> :

"The cathode liberating gas was in substantial excess of the Faraday law value. When the voltage across the circuit was equal to 550 V, the volume of cathodic gas with sodium carbonate solution was equal to 16.97 times the Faraday law value. The study showed that methanol molecules are more active than water molecules. . . . The present research work revealed an innovative application of glow discharge and a new highly efficient hydrogen generation method, which depleted less resource and energy than normal electrolysis and is environmentally friendly."

http://www.ijser.org/researchpaper%5CAnomalous_Hydrogen_Production_during_Photosynthesis_of_NaHCO3_Mixed_Water.pdf

"In this current research the production and the enhancement of hydrogen from the NaHCO₃ mixed water have been investigated under the action of diode pumped solid state laser with second harmonic of wavelength 532nm. The efficiency of the hydrogen and oxygen yields was found to be greater than the normal Faradic efficiency. The parametric dependence of the yields as a function of laser irradiation time, Laser focusing effect and other parameters of the electrolysis fundamentals were carefully studied."

<http://www.scribd.com/doc/6922596/A-novel-method-of-hydrogen-generation-by-water-electrolysis>

"This fact implies that the ultra-short power electrolysis is a promising method in which the power application can be increased even with an increase in electrolysis efficiency."

<http://freenergynews.com/Directory/Organizations/GardnerWatts/index.html>

"Modified electrolysis uses tungsten cathode, platinum anode, applied with high voltage high frequency pulsed DC current results in a plasma being formed between the electrodes, releasing monoatomic hydrogen and further catalytic reactions that produce excess heat. Energy gains range from between 20 - 100 times more output than input. Independently verified at Bristol University."

(<http://phys.org/news/2012-09-scientists-mechanism-water-splitting-catalysts.html>)

"Scientists unlock the mechanism behind improved water-splitting catalysts", Kimm Fesenmaier (September 4, 2012). See also http://en.wikipedia.org/wiki/Photocatalytic_water_splitting

Hydrogen can be used to produce methanol from CO₂:

"Electrolytic synthesis of methanol from CO₂", <http://www.freepatentsonline.com/3959094.html>

"Carbon dioxide hydrogenation to methanol at low pressure and temperature", Bill, Alain; Advisor: Grätzel, Michael, 1997 <http://infoscience.epfl.ch/record/32203>

Beyond oil and gas: the methanol economy, 2nd ed. George A. Olah, Alain Goeppert, G. K. Surya Prakash, 2nd ed., 2009

"Solar thermal process produces cement with no carbon dioxide emissions", Lisa Zyga (2012) <http://phys.org/news/2012-04-solar-thermal-cement-carbon-dioxide.html> (another use for electrolysis: cement production)

"Molecular Dynamics Simulations of Rapid Hydrogen Production from Water Using Aluminum Clusters as Catalysts", Fuyuki Shimojo, Satoshi Ohmura, Rajiv K. Kalia, Aiichiro Nakano, and Priya Vashishta (March 2010) PRL 104, 126102 (2010) <http://128.125.4.56/papers/Shimojo-nAlWater-PRL10.pdf>

"Reaction of Aluminum with Water to Produce Hydrogen A Study of Issues Related to the Use of Aluminum for On-Board Vehicular Hydrogen Storage", (2008) U.S. Department of Energy http://www1.eere.energy.gov/hydrogenandfuelcells/pdfs/aluminium_water_hydrogen.pdf

"Generation of hydrogen from aluminum and water - Effect of metal oxide nanocrystals and water quality", Hong-Wen Wang, Hsing-Wei Chung, Hsin-Te Teng, Guozhong Cao http://depts.washington.edu/solgel/documents/pub_docs/journal_docs/2011/11-IntJHydro-HW%20Wang.pdf

"Methods and Systems for Producing Hydrogen", Howard Phillips <http://www.freepatentsonline.com/WO2013016367A1.html>

Water Capacitors-Chemical:

<http://www.autismpedia.org/wiki/index.php?title=WFC> Water Fuel Cell, (distilled water capacitor)
http://peswiki.com/index.php/WFC#Public_Domain_Waterfuel_Technology

"A novel method for splitting the water molecule, using water as an integral component of a resonant electronic circuit, hints of a possible energy use." A table in the article says conventional electrolysis (using an electrolyte) yields "1 cubic centimeter of gas per 1 amp/hr @ 2 volts potential" whereas distilled water with *no* electrolyte and a 4.73 KHz pulsed resonant circuit yields "4.4 cc of gas per 0.5 amp / hr @ 2 volts potential" or "48.7K cubic centimeters of gas per 0.5 amp / hr @ 12.5 volts potential". (Note the enormous difference claimed for the higher voltage.)

http://peswiki.com/index.php/WFC#Public_Domain_Waterfuel_Technology (discussion, pictures)

<http://www.freepatentsonline.com/5149407.pdf> ("Process and apparatus for the production of fuel gas and the enhanced release of thermal energy from such gas", Stanley A. Meyer, September 1992:

"Water molecules are broken down into hydrogen and oxygen gas atoms in a capacitive cell by a polarization and resonance process dependent upon the dielectric properties of water and water molecules. The gas atoms are thereafter ionized or otherwise energized and thermally combusted to release a degree of energy greater than that of combustion of the gas in ambient air."

(see also <http://www.esmhome.org/library/stan-meyer/stan-meyer-water-fuel-cell-technical-brief.pdf>)

<http://www.freepatentsonline.com/y2009/0283402.html> , "Hydrogen/Oxygen Fuel Generator", Osman, Dana Charles, 2009:

"A compact and portable system adapted for use in decomposing water and separating an oxygen rich gaseous stream and a hydrogen rich gaseous stream which produces a massive output of Hydrogen fuel, (along with the proportional amount of oxygen) capable of operating at varying levels of output, on-demand. This system can interface easily with existing technologies to power standard motor vehicles (gas, diesel, ethanol or hydrogen systems), recreational vehicles, home energy systems and home appliances, commercial/industrial power generators, smelters and much more. . . . The H₂O molecule (referred to as the dielectric), at resonance, is elevated to a state of "hyper resonance" using a hi voltage, low current, configured, composite pulse train keyed to the water molecule electrical constants, causing efficient water molecule fractionation and the on demand production of hydrogen and oxygen from this hyper resonant state. . . . This is not simple Browns gas technology."

See also [Links: Pulsed Power](#)

(disambiguation: See [WaterCapacitor-Electrical](#) for the construction and characteristics of distilled water capacitors used in high voltage research and applications.)

Run your car on water?

The citations above indicate that water can be electrolyzed under certain specific conditions to yield 10 to 4000 times the amount of hydrogen corresponding to the classical Faraday equivalent. In the electrolytic versions, the "excess" hydrogen apparently comes from metal electrodes as well as alkaline metals in the electrolyte. In my view this is solid, very credible research. But it implies you could run your car on hydrogen electrolyzed from a gallon of water and a few tablespoons of baking soda. There are in fact groups of Do-It-Yourselfers (DIY) that claim to be doing just that. However, their devices do not appear to use the specific conditions cited in the research. Still, it is possible that they could be producing over unity hydrogen without knowing about optimum conditions. (The above citations are mostly focused on "excess energy" production; the "excess hydrogen" is simply taken as an indication that something unusual is occurring.) The gas these groups generate and utilize is called "HHO" (hydrogen-hydrogen-oxygen) and sometimes "Brown's gas". The claims about these groups range from "scam" and "gullible" to "real technology" and everything in between. I have not (so far) seen any claims backed by independent testing laboratories, except possibly for the references to the distilled water capacitors, which uses an entirely different technology.

Here are a few of many links for readers who want to investigate.

Pro:

<http://www.twofoldgasmileage.com/index.html> <http://water4gas.com/>

<http://www.hydrogen-gas-savers.com/water-car-groups.htm>
<http://tech.groups.yahoo.com/group/watercar/message/61091>
<http://www.h2purepower.com/technology.html>

Con:

<http://www.popularmechanics.com/cars/alternative-fuel/gas-mileage/4310717-2>
<http://www.msnbc.msn.com/id/29899191/>

Ethanol:

<https://sites.google.com/site/e1004freeread/>

"ALL Brazilian ethanol is hydrous ethanol, containing 4% water. About 90% of all new vehicles in Brazil are flexi-fueled. Some are even "optimized" for ethanol, such as the Ford "Sigma" engine - going in the Focus. This engine gets more power and better mileage running on watered-down ethanol, than it gets on Brazilian gasoline. All E-100 Suzuki vehicles also drop-right-in to the Brazilian system."

"SmartFuel Van using SmartPlugs"

<http://www.youtube.com/watch?v=f6q9HG9oCYI> (video)

Required

reading: http://lege.net/blog.lege.net/Free_Energy/A_Summary_Of_Research_Not_Present_INE22.pdf

Run your car on inert gas? <http://video.google.com/videoplay?docid=-2850891179207690407#> . See also Papp engine references [below](#).

"The problem of creating something which is new, but which is consistent with everything which has been seen before, is one of extreme difficulty. "
(*The Feynman Lectures on Physics*, Vol. II, p. 20-10 to 2011)

Potassium Carbonate Electrolysis cells

"Take water and potash, add electricity and get - a mystery", By Robert Matthews, Science Correspondent
<http://www.telegraph.co.uk/news/uknews/1430416/Take-water-and-potash-add-electricity-and-get---a-mystery.html>

Absolutely Not Cold Fusion (MLP) By imrdkl, Jun 3rd, 2003

<http://www.kuro5hin.org/story/2003/6/2/55742/14178>

<http://www.greaterthings.com/News/FreeEnergy/Directory/Organizations/GardnerWatts/>
<http://rexresearch.com/eccles/1eccles.htm> (WO 00/25320 patent info)

<http://hydrino.org/documents/anomalous-heat-from-atomic-hydrogen.pdf> (H₂ diffusion through nickel tubing submerged in potassium carbonate solution; no electrolysis)

<http://patft.uspto.gov/netacgi/nph-Parser?Sect1=PTO1&Sect2=HITOFF&d=PALL&p=1&u=%2Fnetacgi%2FPTO%2Fsrchnum.htm&r=1&f=G&l=50&s1=5273635.PN.&OS=PN/5273635&RS=PN/5273635>

<http://www.patentstorm.us/patents/5628886/description.html>

<http://jlnlabs.imars.com/cfr/html/hpcfr21.htm>

<http://www.quanthomme.info/jlnlabs/cfr/html/hpcfr21.htm> (Experiments of Jean-Louis

Naudin; <http://jlnlabs.com/>)

See also [Example of electrolytic CFP](#) below.

("New method for the reduction of titanium dioxide which is set to replace the conventional Kroll process...")

<http://www.britishtitanium.co.uk/technology.htm> ; http://en.wikipedia.org/wiki/FFC_Cambridge_process ; http://www.metalysis.com/pdf/FFC_NaturePaper.pdf

Hydrogen gas cell (Randell Mills)

<http://www.blacklightpower.com>

"BlackLight is non-exclusively licensing its process to make power for a fixed royalty payment per kilowatt-hour of thermal or electric. To date, the Company has licensed the rights to produce approximately 8,250 MW of new electrical power to seven companies, including five electrical utilities and two independent power producers. Collectively the combined utility companies own, purchase, or manage electric power production of approximately 7,600 MW and service nearly one million customers. The avoided fuel costs from these agreements could be in excess of \$2 billion per year." http://www.blacklightpower.com/exec_summary.shtml

"Randell Mills --New Energy and the Cosmic Hydrino Sea", Art Rosenblum, *Infinite Energy*, Issue #17, p. 21-35

"THE COLLAPSE OF MATTER, Excess Heat Generation, Fractional Hydrogen Formation, and Nuclear Reactions in a Gaseous Plasma", Arnold G. Gulko, *Infinite Energy*, Issue #34, p. 9-15

Hydrogen gas cell (Les Case)

Dr. Les Case
P.O. Box 495
Greenland, NH 03840 USA
Voice: 603-772-9200, FAX 603-772-9200

<http://www.mv.com/ipusers/zeropoint/IEHTML/DEVICEUPD/25issdevupd01.html>

Rossi Portal Hydrogen gas/nickel device

"Lewan Investigates and Observes Rossi Device",

<http://newenergytimes.com/v2/news/2011/37/LewanInvestigates.shtml>
http://en.wikipedia.org/wiki/Energy_Catalyzer
http://www.nyteknik.se/nyheter/energi_miljo/energi/article3173090.ece
(Rossi's claims do not appear to be substantiated as of June 2011)

"Rossi's scientific failure in seven steps", Steven Krivit, August 2011, <http://newenergytimes.com/v2/sr/RossiECat/RossiScientificFailure7Steps.shtml>

Opinions on the Rossi device seem to be changing. See: Cold Fusion Times, International Conference on Cold Fusion (ICCF-17), August 12-17 2012 <http://world.std.com/~mica/cft.html>

"Andrea Rossi's Black Box", Steve Featherstone, *Popular Science* (November 2012) p.62+

Patterson Power Cell™ (electrolytic)

CETI - Clean Energy Technologies, Inc. (Dallas, Texas)
Voice: 214-982-8340, FAX 214-982-8349

<http://www.connexion.org/kaplan/home.html>

Good Morning America transcript (ABC-TV, June 11, 1997):

http://www.planetarymysteries.com/energy/abc_tran.html

http://www.enterprisemission.com/images/hyper/s_gmarad.gif (picture)

See *Infinite Energy* issues: Vol 3, No.13 and No.14 (1997), pages 14-15 "Radioactivity Amelioration Summary", Clean Energy Technologies, Inc.

Francesco Piantelli's nickel-hydrogen gas experiments

"NASA Advances Evaluation of Piantelli's LENR Research", <http://blog.newenergytimes.com/2011/09/28/nasa-advances-evaluation-of-piantelli%E2%80%99s-lenr-research/>

<http://www.scribd.com/doc/15125148/Secrets-of-Cold-War-Technology> (p.144)

Throughout the years preceding World War II, a small group of widely separated researchers successfully demonstrated the possibility of deriving energy from the atomic lattices of various materials. This development was the result of methodic investigations in photoelectric and photonuclear processes, conducted by Dr. Gustav Le Bon in Belgium (1897). The next appearance of this thought regime came when Dr. Andre Helbronner in France (1920), and Dr. Fritz Paneth and Dr. Kurt Peters in Germany (1926) each independently began studying electrical discharge processes in pure hydrogen gas, a dangerous experimental line to pursue even in university laboratories. Each researcher discovered that "extra energy", in exceedingly great supplies, could be obtained for hours from their experimental apparatus. Long after an initial high voltage electrical discharge had been made to pass across tungsten or palladium arc electrodes, and then withdrawn, their strange and continued red glowing heat was observed. Here was the clearest suggestion that an unknown energy process had been accidentally tapped.

Moller/Frolov Atomic Hydrogen Generator

"J.L. Naudin Claims to Extract Free Energy Using Moller's Atomic Hydrogen Generator (MAHG) *Experimenter claims to derive free energy cleanly and safely from the dissociation and association of hydrogen atoms. Data posted from several tests. Plans, schematics, methods all listed openly to encourage replication and improvement of results. Based on decades-old concepts set forth by Nobel laureate.*" http://pesn.com/2005/06/26/9600116_Naudin_MAHG/ ; "Free Energy from Atomic Hydrogen", <http://jlnlabs.online.fr/mahg/index.htm>

Transmutation / Remediation of radioactive elements (various methods)

Cincinnati Group, LENT-1 reactor, Stan Gleeson

<http://web.gcis.net/cincygrp/>

http://www.padrak.com/ine/NEN_5_3_1.html (Thorium Becomes Titanium & Copper)

http://www.padrak.com/ine/NEN_5_6_1.html (LENT-1 reactor)

http://www.padrak.com/ine/NEN_5_6_5.html (some references)

http://www.padrak.com/ine/NEN_5_9_3.html (conversion of tungsten into silver, barium, tin, chromium, etc.)

http://www.padrak.com/ine/NEN_5_10_2.html ("Where Did the Thorium Go?")

<http://www.angelfire.com/on/GEAR2000/kaplan2.html> (a letter to President Clinton)

http://www.planetarymysteries.com/energy/abc_tran.html Good Morning America transcript (ABC-TV, June 11, 1997) http://www.peswiki.com/index.php/Directory:Nuclear_Remediation#Hoagland_1997_Demonstration_on_Good_Morning_America

http://www.altenergy.org/3/new_energy/cold_fusion/workers/workers.html (Cincinnati Group; Patterson process)

http://www.gdr.org/nuclear_half.htm (Global Deactivation of Radiation Corp.)

<http://www.rexresearch.com/articles/nukewa~1.htm> "Transmutations of Nuclear Waste", Robert A. Nelson, 2000

http://www.idahopress.com/articles/2003/08/25/archive_news/2op8-19.txt

"DOE should pursue accelerated radioactive waste decay", Glen E. Benedict, Nampa, retired nuclear engineer, 2003

See *Infinite Energy* issues

Vol 3, #13&14 (1997), pages 5,13-32 (ABC News; Clean Energy Technologies; Cincinnati Group; Robert Bass; R.T. Bush)

Vol 3, #15&16 (1997), pages 18-23 ("Operating the LENT-1 Transmutation Reactor: A Preliminary Report", Hal Fox, Shang-Xian Jin)

Vol 3, #17 (1997/8), pages 52-53 ("LENT-1 Latest Technical Results", Cincinnati Group)

Vol 4, #20 (1998), pages 26-30 ("Low-Energy Nuclear Reactions and High-Density Charge Clusters", Hal Fox, Shang Xian Jin; see also pages 21-22)

Vol 4, #22 (1998), pages 20-21 ("Aqueous Arc Experiment: Results Presentation", David Marett)

Vol 4, #23 (1999), pages 16-22 ("Non-Stellar Nucleosynthesis: Transition metal production by DC plasma-discharge electrolysis using carbon electrodes in a non-metallic cell", H.E."Chip" Ransford)

Vol 4, #27 (1999), pages 34-39 ("Nuclear Transmutation Reaction Caused by Light Water Electrolysis on Tungsten Cathode Under Incandescent Conditions", T.Ohmori, T.Mizuno)

"Taming a Neutron Star", Stanislav Adamenko, April

2005, <http://pages.csam.montclair.edu/~kowalski/cf/217kiev.html>

Ukrainian scientists bombard a small copper ball with a relatively weak beam of 300 keV electrons. "The target collapses in on itself (shrinks), followed by an explosion and the brightest flash, nuclear transmutation (the occurrence of a great number of elements which the target lacked before) and a stream of various radiation. The energy of the explosion exceeds the initial energy of the electron beam by a million times." Almost 10,000 experiments have been performed. "we obtain isotopes of elements of the entire Mendeleev's periodic table from hydrogen to super heavy elements....These are transuranium and rare isotopes. There is an example – the most distributed isotope of iron is Fe-56. Its proportion of the total weight of iron amounts to approximately 92%. And there is a rare isotope called Fe-57. There is a small amount of it – almost 2.2%. This is the so-called "Mossbauer isotope" which is used in nuclear physics and metrology, and its market value is \$10,000 dollars per gram because it is very difficult to split it from ordinary iron. So, during our experiments we got Fe-57 in higher quantities than Fe-56. Even in this single case one could start commercially feasible production....The fourth moment is applied deactivation. As a result of mini explosions the substance under radiation gets rid of such phenomenon as radioactivity." (Vladimir Vysotsky, Alexander Kochno)

"Transmutations of radioactive isotopes?", Ludwik Kowalski (November 15,

2004), <http://pages.csam.montclair.edu/~kowalski/cf/186radwaste.html> "The Monti Process has been tested many times in the past, including at ENEA, the Italian National Agency for New

Technology, Energy and The Environment, at the Royal Institute of Technology and Science in Stockholm, Sweden, in Taiwan, and at a previous demonstration in Kamloops, B.C., all of which were monitored by independent scientific observers. In all instances, the results were positive, demonstrating that the Monti process could effectively deplete the radioactivity by up to seventy five percent within three to four days."

"Demonstration of the Monti Process at the Royal Institute of Technology Stockholm, Sweden", <http://www.lowenergytransmutations.org/demonstrations.htm> ,

". . . it is possible to achieve transmutation of elements by chemical, electrical, or a combination of chemical and electrical means. There is a great deal of experimental evidence which supports this assertion. Monti America Corporation in association with Dr. Roberto A Monti is working on these processes for commercial application. The priority is to develop a process that converts radioactive wastes into non - radioactive elements."

And:

"When analytical results are tabulated and all apparent variables are considered it is evident that elements are present that were not in the starting batch while others have disappeared or are present in different quantities. The batches we use in our tests are generally in excess of 1.5 kilograms. Close to 500 grams of metal are in the mixture at the start of the reaction. The weight of the new metals or the changed weight of others is in the order of grams, sometimes in hundreds of grams. The magnitude of the changes should rule out experimental errors. . . .The process is ready for expanding to pilot plant stage. There have been over 80 successful tests, over half of them were conducted and/or were evaluated at independent laboratories."

And:

"A contribution from R. Monti described the suppression of the radioactivity of thorium oxide. Monti's method was similar to the method worked on in the summer of 1992. He could reduce the activity from 900 cpm to about 100 cpm in four days of a series of sudden heatings.

Possibilities of de-naturing radioactive wastes appears and have been further developed by Monti and separately by Hal Fox (2003)." ("The History Of The Discovery Of Transmutation At Texas A&M University", J.O'M. Bockris, Molecular Green Technology, College Station, Texas 77845, Revised Version, 6th of August, 2003, <http://www.lenr-canr.org/acrobat/BockrisJthehistory.pdf> ; <http://newenergytimes.com/v2/sr/taubesfabrication/Bockris-AccountabilityAndAcademicFreedom.shtml>)

"Transmutation of metal at low energy in a confined plasma in water", D. Cirillo, V. Iorio, August 2004, <http://jlnlabs.online.fr/cfr/files/CirilloDtransmutat.pdf> "Using an SEM (scanning electron microscope), the presence of rhenium, osmium, gold, hafnium, thulium, erbium, and ytterbium are found on the surface of the cathode. These elements were not previously in the apparatus."

Claims of transmutation of copper to silver and gold 1000 ounces at a time:

<http://www.drjoechampion.com/History/x-files/neurad01.htm> If you read this, please also read the following paper which sheds some light on its history: "The History Of The Discovery Of Transmutation At Texas A&M University", J.O'M. Bockris, Molecular Green Technology, College Station, Texas 77845, Revised Version, 6th of August, 2003 <http://www.lenr-canr.org/acrobat/BockrisJthehistory.pdf> Sidebar: "John O'Mara Bockris. . . is a former professor of Chemistry at Texas A&M University whose unorthodox views have provoked controversy. He has authored, coauthored or edited more than 700 papers and 22 books principally in [electrochemistry](#) but also in environmental chemistry, photoelectrochemistry and bioelectrochemistry. His two volume Modern Electrochemistry (second edition) Plenum, (2000) is commonly used in colleges.^[2]" http://en.wikipedia.org/wiki/John_Bockris

"The transmutation of mercury into gold", Dr. Walther Gerlach (1924) *Frankfurter Zeitung*, evening ed. Friday July 18, 1924 (German language; The conversion effect was noted in encrustations in mercury lamps.)

Lattice Energy LLC - 1994 conference paper - Prof John Dash reported production of gold and silver in electrochemical cell experiment - June 24 2016

<http://www.slideshare.net/lewisglarsen/lattice-energy-llc-1994-conference-paper-prof-john-dash-reported-production-of-gold-and-silver-in-electrochemical-cell-experiment-june-24-2016>

ORME (Orbitally Rearranged Monoatomic Elements) "David Hudson Lectures" <http://www.asc-alchemy.com/hudson.html> (Note the use of high temperatures, electric arcs, and hydrogen)

<http://www.slideshare.net/lewisglarsen/lattice-energy-llc-mystery-of-nagaokas-1920s-gold-experiments-why-did-work-stop-by-1930-dec-27-2013>

"Metallic Transmutations induced by Acetic Acid", Monti *et al.* http://www.lowenergytransmutations.org/documents/metallic_transmutations_by_acetic_acid_primo_dina.pdf

"Transmutations of Mercury to Gold" http://www.levity.com/alchemy/nelson2_7.html , http://www.levity.com/alchemy/nelson2_1.html

"Lattice Energy LLC- LENR Transmutation Networks can Produce Gold-May 19 2012", Lewis Larsen (May 19, 2012)
<http://www.slideshare.net/lewisglarsen/lattice-energy-llc-lenr-transmutation-networks-can-produce-goldmay-19-2012>

"Nuclear Waste Neutralization Technologies", <http://newparadigmdigest.com/5723/nuclear-waste-neutralization-technologies/comment-page-1/> "In the midst of all the stress and fear around the Japan reactors, where is the mandate for immediate research and development of the neutralization and elimination of radioactive waste? Here are some promising technologies that should be publicized, researched, developed and commercialized as soon as possible. Since they have been demonstrated to government officials and the Department of Energy, it seems curious we hear no mention of any of them or even the idea in mainstream media."

"Neutralize All Radioactive Waste", <http://www.innovativetech.us/100123/FutureProd-rw.htm>

There is a growing belief that DOE has long considered nuclear waste (and radioisotopes in general) to be valuable material rather than "garbage" or "waste". This would explain DOE's obvious reluctance to use simple, inexpensive processes to destroy nuclear waste, and to prefer storage instead. Reprocessing nuclear waste is dangerous and currently very expensive, but reuse can multiply the energy available in the original uranium some sixty times. (["China says it knows how to reprocess nuclear fuel"](#)) .

And there is another consideration here too:

Year 1964 marked the demonstration of intentional deactivation of radioactive materials for the sole purpose of eliminating radioactivity in waste. This was the foundation for the Baumgartner Nuclear Half-life Modification Technology which has remained dormant these many years.

In 1964 we thought and believed that radioactivity in nuclear waste would soon be history on planet earth. As history has proven us wrong, we now know and understand that there is a fortune, billions yearly, to be made by saving every scrap of radioactive nuclear waste and trying to bury it in Yucca Mountain and in cleaning up spills, leaks, and escaping radioactive particles from decaying containment schemes. We were just looking at the wrong goal post. No one receiving the funds has any interest in eliminating radioactivity in nuclear waste. Nuclear Half-Life Modification Technology could reduce the cost to a fraction of the cost that is experienced today. ("Radioactivity Deactivation at High Temperature in an Applied DC Voltage Field Demonstrated in 1964". Larry Geer & Cecil Baumgartner, http://www.gdr.org/nuclear_half.htm)

You would think half a century would be enough time for the Federal government to complete research on disposal/destruction of nuclear waste. But they are *still* studying the problem:

The time is long overdue for America to find a new approach for solving the nation's nuclear waste problem. That is why I was joined by Senator John Ensign in proposing the creation of a [Blue Ribbon Commission](#) of experts to make credible, scientifically sound recommendations for a new approach to nuclear waste.

I am pleased that President Obama and Secretary Chu agree with this approach, and on March 3, 2010, announced the creation of the [Blue Ribbon Commission on America's Nuclear Future](#). The commission includes distinguished nuclear energy experts, geologists, policymakers, and environmental policy experts. The panel will present their final report on the best alternatives to Yucca in early 2012. While this commission prepares its report, I will ensure that Nevada's health and safety are never again threatened by nuclear waste. <http://reid.senate.gov/issues/yucca.cfm>

I personally do not see much of a future for commercial nuclear power. The nuclear power industry cannot attract private investment, cannot handle its own liability exposures without government guarantees, cannot process its own nuclear wastes, has routine releases of radioactive gases (xenon, krypton, tritium), and produces high-cost, subsidized, non-competitive electric power. It will eventually just die out due to rapid advances that are making solar and wind power more competitive. Various countries (Japan, Germany, Switzerland, Spain, Italy) have decided to discontinue commercial nuclear power, and other countries are seeing public sentiment turning against more nuclear plants. Additionally, uranium mining is an environmentally unfriendly process. Plus, we would like to get rid of nuclear weapons rather than have a ready means to produce more.

See also [Brian Fraser's Adventures in Energy Destruction](#) .

Some interesting facts about Spent Nuclear Fuel:

- In the United States there are about 103 commercial nuclear reactors producing 20% of our electric power.
- DOE estimates that by the year 2000 there will be over 42,000 metric tons of Spent Nuclear Fuel (SNF), enough to cover a football field with a layer 15 feet thick of stacked fuel rod assemblies. There will be over 80,000 metric tons by 2020.
- One metric ton requires over three million years to decay to the level found in natural uranium ore.
- A 1000 Megawatt boiling water reactor uses about 175 fuel rod assemblies per year. About 30 metric tons of spent fuel is off-loaded every 18 months per reactor, and initially produces 1.5 Megawatts of afterheat per metric ton. The assemblies are stored "temporarily" in special water-filled concrete and stainless steel lined pools at the power plant site so that they can cool for 5 to 10 years. But because reprocessing of commercial SNF raised proliferation concerns, and also was never economically viable, these pools have become de facto storage facilities for SNF. There has been no permanent disposal facility or method in the United States since the first commercial reactor went on line in the early 1960s. The pools now use even denser stacking of spent fuel assemblies and the safety concerns have become even more serious. And since the events of September 11, 2001, most people are convinced that a pile of thousands of tons of this stuff is not a good thing to have around anymore.

- The pools are expensive to operate: about \$4 million to \$25 million per year per pool depending upon the particular pool. The alternative, storage in metal or concrete casks, is also expensive. Neither method actually destroys the radioactivity.

Advantages of CANDU® Reactors (heavy water, natural uranium) http://www.nuclearfaq.ca/brat_fuel.htm

Joseph Papp's Noble Gas Engine (US Patents 3,670,494, 3,680,413, 4,428,193)

The Papp engine is a piston engine that has no intake and no exhaust ports. It runs on a sealed internal charge of a mixture of noble gases, and an electronically controlled "plasma transition" process that extracts energy from the gases. It has been around in various forms since the late 1960s or early 1970s..

<http://www.infinite-energy.com/iemagazine/issue51/papp.htm>
<http://www.infinite-energy.com/iemagazine/issue51/>
<http://www.infinite-energy.com/iemagazine/issue52/>
<http://video.google.com/videoplay?docid=-2850891179207690407#>

<http://www.plasmerg.com/doc.html>
<http://pappengine.com/videos.htm> (plenty of videos)
http://www.youtube.com/watch?v=BzEkbXcWqEk&feature=player_embedded

[Josef Papp: US Patent # 3,670,494; "Method & Means of Converting Atomic Energy Into Utilizable Kinetic Energy"](#)

[Josef Papp: US Patent # 3,680,431; "Method & Means For Generating Explosive Forces"](#) (Abstract only)

<http://www.nuenergy.org/pdf/PAP3680431.pdf>

[Joseph Papp: US Patent # 4,428,193; "Inert Gas Fuel, Fuel Preparation Apparatus, & System..."](#)

http://pesn.com/2009/11/21/9501589_PlasMERG_Noble_Gas_Engine_Patent_Accepted/

<http://virgin-engine.com/> or <http://www.plasmerg.com/>
<http://www.free-energy-info.co.uk/D11.pdf>

See also [Patent 7076950](#) , "Internal Explosion Engine and Generator Using Non-Combustible Gases", H.F. Klostermann, Jul 18, 2006. (This one uses air)

There is currently no accepted explanation for how this kind of engine works. It does make use of magnetic and electric fields, which suggests an effect related to atomic spin systems. See [Origin of Intrinsic Spin](#) and read item #10 in the list near the end of the article. Possibly also relevant is: <http://newenergytimes.com/v2/news/2006/NET19.htm#ee> which also uses electric and magnetic fields. Conversion of "excess mass" is probably the source of energy. See [Advanced Atomic Energy Converters#ExcessMass](#) and [Update 11-27-08 in Adventures in Energy destruction](#). (Excess mass is my own term denoting the difference between twice the atomic number and the actual Periodic Table mass. This mass (conventionally attributed to neutrons) has a somewhat foreign character compared to the primary atomic structure, and is apparently relatively easy to "detach" and convert into energy. The conversion process appears to involve electrons, neutrinos, and a couple of as-yet-undiscovered massless particles, whose existence is implied by extending the Periodic Table "backwards" into the preatomic range of massless particles)

Recently, even thunderstorms have been found to produce gamma rays in excess of 10 MeV :

"Although TGFs are quite brief (1-2 milliseconds), they appear to be the most energetic events on Earth. They belch destructive gamma-rays packing over ten million times the energy of visible light photons – enough punch to penetrate several inches of lead." ("Are TGFs Hazardous to Air

Travelers?", http://science.nasa.gov/headlines/y2010/10feb_friendlyskies.htm ; <http://news.yahoo.com/dark-lightning-sparks-call-more-earth-gazing-satellites-190847240.html>)

This implies that extremely high powered energy sources may be more accessible, simple, and ordinary than we previously believed —once we understand the operational principles.

Also:

"Control of chemical Reactions with Magnetic Fields", J.C.

Scaiano, <http://www.uottawa.ca/publications/interscientia/inter.1/magnetic.html>

See the latest video: "Dan Glover on Inteligentry's Noble-Gas Engine", August 3rd, 2012 <http://www.americanantigravity.com/video/dan-glover-on-inteligentrys-noble-gas-engine.html>

Some inadvertent experiments may have been done on this in Nazi Germany:

"There is a rumor that the Germans tested a reciprocating engine, (like an automobile engine), which used atmospheric oxygen to oxidize atmospheric nitrogen. This was said to have involved very high voltage sparks to produce temperatures near 50,000 degrees within the combustion chamber. . . . but, in addition to this, was to inject super-cold liquid helium directly into the combustion chamber. Helium is an inert gas. It does not burn. . . ." ("Richard Miethe" <http://greyfalcon.us/restored/The%20Miethe%20Story.htm>)

The object here was simple conventional cooling and conventional expansion of helium. But could they have stumbled onto something like what is described in the Klostermann patent (above) ?

Electroaerodynamics and the Biefeld Brown effect:

These effects have nothing to do with "cold fusion" or Low Energy Nuclear Reactions (LENR). Instead, they utilize the effects of very intense electric fields. Electroaerodynamics is used to reduce *drag* on aircraft and missiles, especially at high speeds. The Biefeld-Brown effect is used to produce *thrust*.

Research on these topics has mostly an aerospace focus, but there may be more down-to-earth and immediate applications as well. The technology could be used to increase gas mileage for automobiles, or reduce fuel expenses on long-distance trucking. The improvements, of course, would not be nearly as dramatic as those in aerospace. But the requirements in these applications would be much more easily satisfied than those in aerospace applications, and could be demonstrated by almost any advanced electronics hobbyist.

See:

[Mitigation/Elimination of Sonic Shock Waves](#)

[The Biefeld-Brown Effect](#)

See also the list of links pertaining to production of megavolt, kiloamp, terrawatt pulsed power at "Capacitor Tests" <http://scripturalphysics.org/4v4a/CapacitorTests/CapacitorTests.html> .

Various News Media Report New DOE Review of Cold Fusion

<http://www.infinite-energy.com/resources/inthenews.html>

Various News Media Report New DOE Review of Cold Fusion (March 20, 2004)

<http://www.spacedaily.com/news/energy-tech-04w.html>

DoE To Revisit Cold Fusion, Charles Choi (Apr 02, 2004)

<http://www.iht.com/articles/511877.html>

New studies of cold fusion prompt an official review, Kenneth Chang NYT (March 25, 2004)

<http://www.physicstoday.org/vol-57/iss-4/p27.html>

DOE Warms to Cold Fusion (Toni Feder)

<http://www.open-economy.org/modules.php?op=modload&name=News&file=article&sid=291>

US Department of Energy warms to Cold Fusion (Toni Feder)

<http://popularmechanics.com>

"America's Worst Nightmare:

HOMEBUILT H-BOMBS

Cold Fusion Technology Enables Anyone To Build A Nuke From Commonly Available Materials" (August 2004, p. 74-79)

Conventional Technologies

Petroleum alternatives

<http://www.discover.com/issues/may-03/features/featoil/> Discover magazine Vol. 24 No. 5 (May 2003)

"Anything into oil"

<http://www.spiritofmaat.com/announce/newoil.htm>

<http://lists.envirolink.org/pipermail/ar-news/Week-of-Mon-20030804/004435.html>

<http://www.changingworldtech.com/home.html> (Changing World Technologies)

"Chemical engineers boost petrochemical output from biomass by 40 percent" (Jan 2012)

<http://www.physorg.com/news/2012-01-chemical-boost-petrochemical-output-biomass.html>

<http://www.rexresearch.com/karrick/karric~1.htm> (Lewis Cass Karrick, article)

<http://www.rexresearch.com/karrick2/kltcusp.htm> (Lewis Cass Karrick, patents)

<http://www.age.uiuc.edu/bee/research/tcc/tcc.html> (Thermochemical Conversion (TCC) of Livestock Manure.
..)

<http://www.age.uiuc.edu/bee/research/tcc/tccpaper1.htm>

<http://www.age.uiuc.edu/bee/research/tcc/tccpaper2.htm>

<http://www.age.uiuc.edu/bee/research/tcc/tccpaper3.htm>

<http://www.prnewswire.com/news-releases/primus-green-energy-raises-12-million-for-renewable-gasoline-technology-142614276.html>

Roesel Engine

Ethanol to hydrogen (catalytic conversion)

<http://www.cnn.com/2004/TECH/science/02/13/hydrogen.reactors.ap/> (Lanny Schmidt, University of Minnesota)

http://news.mpr.org/features/2004/02/12_olsond_hydrogen/
<http://www.wired.com/news/technology/0,1282,62439,00.html>

Alternative Nuclear Power

"Development of Tiny Thorium Reactors Could Wean the World Off Oil In Just Five Years", Rebecca Boyle, 8-30-2010, <http://www.popsoci.com/technology/article/2010-08/thorium-reactors-could-wean-world-oil-just-five-years>

"The Road to Fukushima: The Nuclear Industry's Wrong Turn", Kurt Cobb, April 2011, http://scitizen.com/future-energies/the-road-to-fukushima-the-nuclear-industry-s-wrong-turn_a-14-3645.html

Storage of Electrical Power

"Process and apparatus for renewing exhausted primary, more particularly dry, electric cells or batteries," Ernst Beer, June 26, 1956. (<http://www.freepatentsonline.com/2752550.pdf>)

Some interest by NASA (http://pages.ripco.net/~marnow/uk/NASA_Vargo_Start.html) :

". . . it is well known in the plating field that periodic current reversal methods can plate coatings at a much faster rate than can be done by conventional direct current methods. It is further known that the reverse-current part of the charging cycle will tend to act as a depolarizer. Use of this technique should lead to significantly higher battery-charging rates. Furthermore, a problem with dc chargers is that the electrode material is plated on as a loose, spongy mass which often falls off and ultimately leads to battery failure. The current characteristic of this battery charger is similar to that used in electropolishing circuits and because of this characteristic, electrode material should be replated as a smooth, hard surface (ref. 1), thereby contributing to increased reliability and long life." (Brief Investigation of an Asymmetrical Alternating-Current Battery-Charging Technique by Donald J. Vargo)

From the original patent, <http://www.freepatentsonline.com/2752550.pdf> :

". . . a current is passed through the cells or batteries to be treated, consisting partly of alternating current and the remainder of direct or pulsating direct current. For charging or renewing normal commercial cells or batteries, the treating circuit can therefore include a rectifier with a very considerable leak (50-90%) or a rectifier bridged by a resistance. . . . Experiments with dry hearing aid batteries and pocket lamp batteries have shown, that by a treatment according to the invention the life of such batteries can be lengthened to 20 to 30 times the normal life."

The process was originally intended for *primary* batteries, which were not intended to be recharged. This technology comes from the 1950s and can easily be done today, even by hobbyists (or as a science fair project). Wouldn't you like to have rechargeable batteries that last 20-30 times normal? Do you think that there would be a market for such a charger? Especially for car batteries . . . ? For home power plants . . . ?

"Utilization of poly(ethylene terephthalate) plastic and composition-modified barium titanate powders in a matrix that allows polarization and the use of integrated-circuit technologies for the production of lightweight ultrahigh electrical energy storage units (EESU)" <http://www.freepatentsonline.com/7466536.html> , <http://en.wikipedia.org/wiki/EEStor>

<http://lenr-canr.org/acrobat/StormsEastudentsg.pdf>

"This paper reports the successful creation of a new ultracapacitor structure that offers a capacitance density on the order of 100 to 200 Farads per cubic centimeter; versus the current state of the art capacitance density of 1 F/cm³. " ("New mega-farad ultracapacitors", Bakhoun, E., 2009, http://ieeexplore.ieee.org/xpl/freeabs_all.jsp?arnumber=4775259

"We report the observation of extremely high dielectric permittivity exceeding 10^9 and magnetocapacitance of the order of $10^4\%$ in La_{0.875}Sr_{0.125}MnO₃ single crystal." ("Giant dielectric permittivity and magnetocapacitance in La_{0.875}Sr_{0.125}MnO₃ single crystals", R. F. Mamin, T. Egami, Z. Marton, and S. A. Migachev, 29 March 2007; DOI: 10.1103/PhysRevB.75.115129 ; PACS numbers: 77.22. d, http://repository.upenn.edu/cgi/viewcontent.cgi?article=1158&context=physics_papers

Advances in Solar Power Technology

"RSi's ChemArc Process produces very high purity silicon ("six nines" which is between metallurgical grade and electronic grade silicon "nine-nines"). The process uses wet chemistry to purify feedstocks before conversion to elemental silicon. Sodium silicate is the source of silicon and sugar is the source of carbon for the reduction process. The silicate solution is stripped of boron in an ion exchange process and then converted to a colloidal silica suspension in water. It then is treated with a cationic/anionic exchange process to remove all other ions (iron, calcium, aluminum, titanium, etc.) The sugar solution is similarly purified, and then pyrolyzed to carbon. The silica and carbon are heated in a electric furnace at ever increasing temperature and the mixture converts to quartz, silicon carbide, and eventually elemental silicon, which is cast into ingots. The directional solidification used in solar cell manufacturing results in an additional factor of ten purity ("seven nines"). The process is much cheaper than what is currently used to produce electronic grade silicon."

Links:

<http://www.engineeringtv.com/video/RSis-ChemArc-Technology->

[Produce http://www.engineeringtv.com/video/The-Chemistry-of-RSis-ChemArc-P](http://www.engineeringtv.com/video/The-Chemistry-of-RSis-ChemArc-P)

<http://www.engineeringtv.com/video/Tour-of-RSi-Solar-Grade-Silicon>

<http://www.rsi-silicon.com/>

<http://www.sumobrain.com/patents/wipo/Method-making-silicon-solar-cells/WO2007106860A2.pdf>

<http://www.wipo.int/patentscope/search/en/WO2007106860>

"Breakthroughs" in solar power:

"5 breakthroughs that will make solar power cheaper than coal", Karl Burkart, <http://www.mnn.com/green-tech/research-innovations/blogs/5-breakthroughs-that-will-make-solar-power-cheaper-than-coal>

<http://www.rdmag.com/News/2011/11/Energy-Solar-Energy-Fools-Gold-Leads-To-New-Options-For-Cheap-Solar-Energy/>

"Wrinkles and twists boost power from solar panels", <http://www.rdmag.com/News/2012/05/Energy-Wrinkles-And-Twists-Boost-Power-From-Solar-Panels/>

"Solar-grade silicon at low cost", <http://www.cam.ac.uk/research/features/solar-grade-silicon-at-low-cost/>

The two-stage process Cox has been developing uses white sand and calcium chloride (a product used commonly in the food industry) as raw materials. First, tablets of compressed sand are immersed into the calcium chloride electrolyte and heated to 900°C. The silicon in sand is present as an oxide and, during the FFC process, the oxygen atoms are ionised, migrate to the anode and are discharged as oxygen, which is the only by-product of the reaction. . . .

In the second stage, an electrorefining process within the same cell takes silicon from 99.99% purity to the Holy Grail of 99.9999% purity.

Advances in Wind Power technology

Windspire windmill, <http://www.windspireenergy.com/windspire/photos-and-videos/>

"A surprising aerodynamic innovation in wind turbine design called the 'wind lens' could triple the output of a typical wind turbine", Karl Burkart, Aug 29 2011 <http://www.mnn.com/green-tech/research-innovations/blogs/japanese-breakthrough-will-make-wind-power-cheaper-than-nuclea>

Australian Company Launches World's Quietest Wind Turbine, <http://www.azocleantech.com/news.aspx?newsID=15749>

Owl wing design:

<http://www.lenovoblogs.com/insidethebox/2007/05/what-do-owls-and-thinkpads-have-in-common/>
http://www.americanzephyr.com/img/Airdolphin%20Series_1-8.pdf , http://www.zephyreco.co.jp/en/products/product/air-dolphin/featur_02.html

<http://serescodehumidifiers.com/dehumidifiers/features-and-benefits/owl-wing-blade-oacc-fans.php>

"Aerodynamic Influence of Leading-Edge Serrations on an Airfoil in a Low Reynolds Number- A Study of an Owl Wing with Leading Edge Serrations", Shinichiro ITO, http://www.jstage.jst.go.jp/article/jbse/4/1/4_117/article

Engine nacelle design:

http://www.boeing.com/news/frontiers/archive/2005/december/ts_sf07.html
<http://low.highbusiness.com/post/285207714/the-engine-nacelles-on-the-boeing-787-feature>
<http://www.space.com/4039-clean-quiet-powerful-engines-jets.html>
<http://www.wired.com/autopia/2009/12/boeing-787-dreamliner/>

Directories and publications:

<http://www.infinite-energy.com/images/pdfs/samplearticle.pdf> (117 pages; wait for it to load)

<http://www.connexion.org/kaplan/home.html>

<http://www.padrak.com/ine/>

<http://www.mv.com/ipusers/zeropoint/> , <http://www.infinite-energy.com>

<http://world.std.com/~mica/cftsci.html>

<http://lenr-canr.org/> (good source for original articles)

<http://lenr-canr.org/acrobat/BarnhartBtechnology.pdf> (Defense Intelligence Agency article, Nov 2009)

http://www.theorionproject.org/en/documents/Gary_V.pdf (tales of energy invention suppression)

For a little bit more about "excess mass" see [Advanced Atomic Energy Converters](#) at this website.

Recommended Reading:

<http://lenr-canr.org/acrobat/StormsEastudentsg.pdf>, *A Student's Guide to Cold Fusion*, Edmund Storms, (January, 2003) This is "a guide" to CF work with overviews about anomalous energy production, anomalous nuclear products, theory, comments, and an extensive bibliography with 249 references. If you are a serious researcher in the CF field, this publication is a good place to start.

UPDATE 12-13-01: There are some experimental indications that ordinary hydrogen (protium) may be a necessary participant in the deuterium/palladium cold fusion cells. Researchers have noticed that neutrons and excess heat are observed only after a long period (many days) of electrolysis, and that these effects often occurred when the cell was replenished with new electrolyte. It is also known that heavy water tends to absorb ordinary water vapor from the air (and other sources) and so with time, these cells acquire a certain amount of protium as a contaminant. The presence of this ordinary hydrogen might be a trigger for the "bursty" production of neutrons and heat seen in these cells. To investigate this possibility, Tadahiko Mizuno, *et al.*, devised an experiment that electrolytically loaded a palladium wire with pure deuterium in a heavy water cell for three hours, and then transferred the wire to a light water cell and resumed electrolytic loading with protium.

Neutrons were detected with the following setup:

Neutrons were measured with three external He^3 detectors placed above the cell. The detectors were calibrated with a standard Cf^{252} neutron source (2.58×10^4 decays/s). To reduce noise, the detector was covered by electromagnetic shielding. After calibration, neutrons and noise were distinguished by covering one of the detectors with a 0.5 mm thick Cd film. The background count was 0.008 ± 0.003 c/s.

Neutron emissions were observed in five test cases out of ten. In one case neutron emissions were seen after 50 minutes of light water electrolysis but "in other runs neutron emission was observed immediately after light water electrolysis commenced. . . total neutron count ranged from 10^5 to 10^6 , and emissions generally lasted $10 \sim 200$ s. All cases were marked by a characteristic high level of neutron emissions at first, which gradually declined." The authors conclude: "The reaction we observed came about after alternating absorption of deuterium followed by protium, and the reaction appears to be highly reproducible, reliably generating high neutron emissions." (The intent of this experiment was to generate neutrons, not power. But in case you are wondering, a commercial nuclear reactor generates about 10^8 neutrons per watt of thermal power. See *Quantum Physics . . .*, R. Eisberg, R. Resnick, 2nd ed. (1985) p. 607)

(For further details see "Neutron Evolution from a Palladium Electrode by Alternate Absorption Treatment of Deuterium and Hydrogen", Tadahiko Mizuno, Tadashi Akimoto, Tadayoshi Ohmori, Akito Takahashi, Hiroshi Yamada, and Hiroo Numata, Jpn. J. Appl. Phys. Vol. 40 (2001), pp. L989-L991, Part 2, No. 9A/B, September 15, 2001. A shorter version of the paper appears in Infinite Energy, Vol. 7, Issue 40 (2001) p. 69-70.)

UPDATE 5-4-02: A review of a list of several experiments published by Dr. John Dash, *et al.*, at Portland State University showed the following about the Cold Fusion Phenomenon (CFP):

"Looking into this list and reading these papers, we notice that their experiments have been done with electrolyte H_2SO_4 in D_2O , cathodes of Pd, Ti, and Ni, and anodes of Pt. This shows that the CFP revealed in these data sets have occurred in metal/D+H systems. . . . In the analysis, it has become clear again that H and D participate together in the events of CFP, generation of excess heat and transmuted nuclei, and shaping pits or craters by explosion of droplets of melts in the surface layer. . . . Now it is becoming further clearer that CFP is not primarily related with d-d fusion reactions in solids but related with reactions occurring in transition-metal hydrides and deuterides by some catalytic effects of unknown agent(s) . . ." (CFRL English News No. 30 (201. 12. 10) Cold Fusion Research Laboratory, Dr. Hideo Kozima) <http://web.pdx.edu/~pdx00210/CFRLNews/CFRLEngNews/CFRLN30.htm>

In my view, the bare essentials of the electrolytic Cold Fusion Phenomenon include the following:

1. The presence of "excess mass". This can be provided by isotopes (like deuterium), or heavy elements (like tungsten), or probably any radioactive element (including thorium, uranium, and potassium-40). It may be supplied by the electrolyte or by the electrode. See [Advanced Atomic Energy Converters](#) for a more complete discussion about "excess mass."
2. The presence of electrons. The experiments showing transmutation effects seem to work best at high current densities (about 2 to 5 amps/cm²; 0.8 to 1.5 for tungsten) and higher than normal temperatures. Hundreds of volts (instead of just a few volts) may be required to reach these current densities. The cathode emits light and so the process has been called "glow discharge electrolysis" or "incandescent electrolysis", "plasma electrolysis", etc. RF shielding and decoupling techniques are used to suppress the radio frequency emissions which can interfere with instrumentation. In atmospheric pressure cells, a reflux condenser can be used to condense the steam produced and return it to the cell as water.
3. The presence of ordinary hydrogen (protium). I suspect that hydrogen or the hydrogen-like subatomic particle [described above](#) may be involved in massless particle conversions that facilitate these reactions.
4. The use of a hydrogen absorbing cathode (Pd, Ni, Ti, Zr, etc) seems to be preferred. But ultrapure carbon electrodes work too, as do gold and tungsten. The latter is preferred because it has a high atomic weight, has a high melting point, and is easily obtained from a welding shop or hardware store. Surface effects on the electrodes appear to be very important. In one case, a wrong polarity hookup may have prepared a Pd electrode for better results. (The Cincinnati Group actually uses alternating current in its cell that has zirconium electrodes. For more on pure carbon experiments see "Production of Metals from Non-Metallic Graphite, Edward Esko, esko@berkshire.net)

Here is an example of electrolytic CFP:

"When a tungsten cathode is electrolyzed at high power, it exhibits an intense reddish-purple glow discharge, and emits radio frequency (RF) electromagnetic waves. In some cases powerful excess heat, ranging from 60 to 140 watts is generated, and substantial amounts of new elements are formed, including Fe, Cr, Ti, Ca, Ni, C, Re, and Pb. This has been observed with many different electrolyte solutions including Na₂SO₄, Na₂CO₃, NaClO₄, K₂CO₃, KNO₃, Rb₂CO₃, CsCO₃, Ba(NO₃)₂ and Ba(ClO₄)₂. . . . In an Au/H₂O electrolysis system, considerable amounts of Hg, Kr, Ni, Fe and , in some cases, Si and Mg were produced on and in the electrode. . . . This suggests that the excess heat reaction might be enhanced by employing as electrode material a metal with a large atomic number In this respect tungsten (W) would be one of the most favorable electrode materials because it has a large atomic number and resistance to high heat. For this reason, we selected W as the working electrode material. . . . large amounts of excess heat were generated in every test, the yield being virtually the same whatever electrolyte was used. . . . Energy efficiency, output as a percent of input, was 150 to 220%, mainly in the range of 180 to 200%. . . . the excess power of 200 watts was generated from a W electrode of only 0.5 cm²." ("Nuclear Transmutation Reaction Caused by Light Water Electrolysis on Tungsten Cathode Under Incandescent Conditions", Infinite Energy, Vol 4, #27 (1999), T.Ohmori, T.Mizuno; pages 34-39)

See also [Potassium Carbonate Electrolysis Cell](#) above.

There are also gas plasma versions of these experiments. Note the use of atomic hydrogen and tungsten in this article: "J.L. Naudin Claims to Extract Free Energy Using Moller's Atomic Hydrogen Generator (MAHG)", http://pesn.com/2005/06/26/9600116_Naudin_MAHG/ . See also Thermacore's non-electrolytic experiment with nickel tubing and hydrogen gas described [below](#).

Some of the "cold fusion" experimental setups are simple enough to be constructed and demonstrated by a high school chemistry/physics student working under professional supervision (there are hazards due to high voltages, hot corrosive solutions, explosive gases, ultraviolet radiation, some radioactivity, breakage of glass, etc). Such demos are good lessons in chemistry, instrumentation, elementary calorimetry, attention-to-detail, safety, and scientific sleuthing. (See [Brian Fraser's Adventures in Energy Destruction](#) ; Source for small quantities of Deuterium

Oxide: http://unitednuclear.com/index.php?main_page=product_info&cPath=16_17_69&products_id=135)

In general however, CFP is a field for electrochemists, materials scientists, and nuclear engineers. Standard analytical techniques and tools of materials science and nuclear engineering are useful for detecting elemental transmutations. These include Electron Probe Micro Analysis, Auger Electron Spectroscopy, X-ray fluorescence spectroscopy (XRF, WDXRF, EDXRF, XRMF), X-ray photoelectron spectroscopy (XPS), energy dispersive X-ray spectrometry (EDS), inductively coupled plasma-atomic emission spectrometry (ICP-AES), Neutron Activation Analysis, Secondary Ion Mass Spectrometry, and of course the usual alpha, beta, and gamma radiation detection, neutron counting, etc.

UPDATE 8-21-02: The military is also showing interest in CFP:

"By the Second International Conference on Cold Fusion, held at Villa Olmo, Como, Italy, in June/July 1991, the attitude toward Cold Fusion was beginning to take on a more scientific basis. The number of flash-in-the-pan ``believers" had diminished, and the ``skeptics" were beginning to be faced with having to explain the anomalous phenomenon, which by this time had been observed by many credible scientists throughout the world. Shortly after this conference, the Office of Naval Research (ONR) proposed a collaborative effort involving the Naval Command, Control and Ocean Surveillance Center, RDT&E Division, which subsequently has become the Space and Naval Warfare Systems Center, San Diego (SSC San Diego); the Naval Air Warfare Center, Weapons Division, China Lake; and the Naval Research Laboratory (NRL). The effort's basic premise was to investigate the anomalous effects associated with the prolonged charging of the Pd/D system and ``to contribute in collegial fashion to a coordinated tri-laboratory experiment." . . . It is time that this phenomena be investigated so that we can reap whatever benefits accrue from additional scientific understanding. It is time for government funding organizations to invest in this research." (Dr. Frank E. Gordon, Head, Navigation and Applied Sciences Department, Space and Naval Warfare Systems Center, San Diego)

See **Technical Report 1862, February 2002, "Thermal and Nuclear Aspects of the Pd/D₂O System"**. This report is "Approved for public release; distribution is unlimited SPAWAR Systems Center San Diego, SSC San Diego, San Diego, CA 92152-5001. P.A. Miller, CAPT, USN Commanding Officer R.C. Kolb, Executive Director"

Volume 1: A Decade of Research at Navy Laboratories (S. Szpak, P.A. Mosier-Boss, Editors)

<http://bitops.com/~mathias/tr1862/html/volume1/>

<http://bitops.com/~mathias/tr1862/tr1862-volume1.pdf>

<http://www.spawar.navy.mil/sti/publications/pubs/tr/1862/tr1862-vol1.pdf>

Volume 2. Simulation of the Electrochemical Cell (ICARUS) Calorimetry

<http://bitops.com/~mathias/tr1862/html/volume2/>

<http://bitops.com/~mathias/tr1862/tr1862-volume2.pdf>

<http://www.spawar.navy.mil/sti/publications/pubs/tr/1862/tr1862-vol2.pdf>

UPDATE 11-11-06: "Extraordinary Evidence", by Bennett Daviss and Steven Krivit, New Energy Times, Nov 10, 2006, <http://newenergytimes.com/v2/news/2006/NET19.htm#ee>

"Scientists at the U.S. Navy's San Diego SPAWAR Systems Center have produced something unique in the 17-year history of the scientific drama historically known as cold fusion: simple, portable, highly repeatable, unambiguous, and permanent physical evidence of nuclear events using detectors that have a long track record of reliability and acceptance among nuclear physicists."

The article describes a fast method of loading Pd by using "co-deposition, combined with the application of external electric and magnetic fields". "The required 1-1 ratio of deuterium to palladium is achieved almost instantly. . . . Minutes, or even moments, after co-deposition starts, the cells show such signature evidence of nuclear reactions as anomalous amounts of tritium, low-intensity x-ray radiation, and increased heat." The setup uses plastic CR-39 detectors. The article has good photos and drawings, plentiful details, and hints for creative experimenters and student projects.

The use of electric and magnetic fields raises another question: do the fields have an effect on spin, and do those effects have anything to do with the ease of energy production or the difficulty of reproducibility? Or do the fields simply stir up the surface chemistry (so to speak)?

Molecular hydrogen, for instance, consists of a mixture of *ortho*-hydrogen and *para*-hydrogen. It may be desirable, say, in an experiment unrelated to "cold fusion", to convert this mixture into *para*-hydrogen. But the conversion is not readily obtained by cooling. "To bring about the conversion more rapidly, a catalyst may be introduced. The gas chemisorbs on the surface of the catalyst as atoms, and the atoms, and their nuclear spins, recombine at random; in due course the equilibrium populations are attained. Interconversion can also be brought about non-dissociatively by bubbling the gas through a solution of a paramagnetic species. The species gives rise to a magnetic field that is inhomogeneous on a atomic scale, and this field can induce the relative reorientation of nuclear spins (as in singlet-triplet transitions between electronic states . . .)." (*Molecular Quantum Mechanics*, Atkins and Friedman, 2005, 4th ed., p.355-356)

It would be easy to say that the fields and conditions in the above set-up are not of the sort that can alter spin. But we know something very unusual is going on in these experiments. The possibility of "spin effects" is another "loose end" that needs to be investigated. Catalysts and magnetic fields have been used in other "cold fusion" experiments with interesting results. See [Update 2-27-04](#) below.

Request For Information (12-13-02): Updates 12-13-01, 5-4-02 suggest that *both* protium and deuterium may be involved in the "cold fusion" phenomena and that they must be present simultaneously. Apparently, the early

experiments used either light water or heavy water but not a deliberate mixture of both. The ones that used heavy water had protium as an eventual contaminant. The ones that used light water of course always had a tiny amount of deuterium (0.015%) present. Although both approaches produced excess heat, the experiments were hard to reproduce and the heat output was (usually) nothing spectacular. This suggests two obvious experiments:

1. Cold fusion with "enriched water". Enriched water would be a 50:50 mixture of light water and heavy water (or at least a few percent of heavy water). A representative experiment would electrolytically load a palladium wire (or rod) with both hydrogen isotopes using any of the conventional techniques. The object of the experiment would be to answer the following questions:

- Does this arrangement produce excess heat (or neutrons, or other indicators of cold fusion)?
- Does the heat appear at relatively low loading ratios (say .5 instead of 0.9 H:PD) ?
- Is the heat production hard to control? (Please use CAUTION here.)
- Is a "heat-after-death" phenomenon observed with this type of experiment?

2. Cold fusion inside a protium/deuterium "transistor". Such a device would consist of two hydrogen absorbing rods (or wires), one loaded with deuterium, and the other loaded with protium. The rods are removed from electrolysis and then joined end-to-end (spot welded ?) so that there is a junction between the deuterium rod and the protium rod. An alternative procedure would be to load one rod in a special electrolytic setup so that one half would load with protium and the other half with deuterium. Electrical connections are then made to the two ends and to the middle of the assembly. Electron current is sent in from the ends of the rods to the center, where it is withdrawn by the center electrode. The object of the experiment would be to answer the following questions:

- Does electromigration cause the protium and deuterium to meet in a localized region near the center connection?
- Is excess heat produced in this region?
- If there is a reaction, can it be switched off by momentarily reversing the current?
- Is the reaction easily controlled, or is there still a "heat-after-death" phenomenon?
- Is switching speed affected by using metals like aluminum which have low hydrogen capacity but high hydrogen mobility?

A quick search (on the Internet) did not find any information on this kind of experiment (or the other types that use activated carbon/palladium, or ceramic proton conductors). My impression is that investigators have been guided by an incorrect theory and have been careful not to mix the two hydrogen isotopes. If you know of any experiments like the above (with positive or negative results) please send me an email.

Update 2-27-04: It is now well established that hydrogen can have anomalous effects in quite a variety of systems:

Electrolysis has also produced success using nickel cathodes with a H₂O containing electrolyte ... platinum with D₂O... and titanium with D₂O Increased temperature ... applied RF energy ... and laser light... appear to enhance the effects. Use of voltage sufficient to create plasma ... in the electrolyte has been found to generate a variety of anomalous nuclear reactions when palladium, tungsten or carbon ... is used as the cathode.

Anomalous effects have been seen during a variety of chemical reactions when deuterium is present.... Sudden heating of titanium charged with D₂ ... or cooling of titanium in D₂ gas ... results in neutron emissions. Many chemical reactions involving deuterium have been reported to generate

neutrons, including the setting of Portland cement. Nuclear effects have also been reported to involve biological systems in the presence of both D₂O ... and H₂O.... Although the number of nuclear events is small in these environments, conventional theory would have none produced.

Hydrogen is also found to be nuclear active in some environments. Anomalous effects are produced by specially treated nickel surface when exposed to hydrogen gas ... Nickel, when it is repeatedly loaded and deloaded using hydrogen gas, appears to produce tritium Hydrogen can also produce transmutation products and detectable energy Even tritium, when reacted with finely divided titanium ... experiences a change in its decay rate. —*A Student's Guide to Cold Fusion*, Edmund Storms, (January, 2003), p. 5-7

Around 1993 Thermacore performed an interesting non-electrolytic experiment. It used 6 meters of nickel tubing immersed in 0.6 molar potassium carbonate solution in a vessel pressurized with nitrogen to suppress boiling. The insulated vessel was heated with an external heater (35 watts), and finally stabilized at 215 ° C above the 18 ° C lab ambient. The nickel tubing was then pressurized with ordinary hydrogen to 70 atm (about 1000 psi). Subsequently, the temperature rose to 301 ° C above ambient, at which point the nickel tubing was vented to atmosphere to prevent activation of the vessel's relief valve. Subsequently, the temperature began dropping back down. No electrolysis was involved in this experiment.

A control cell with sodium carbonate solution gave only a weak effect. Unfortunately, no comparisons were given for a cell with rubidium carbonate solution. <http://hydrino.org/documents/anomalous-heat-from-atomic-hydrogen.pdf>

Mizuno, *et al.* have "observed neutron emissions from pure deuterium gas after it was cooled in liquid nitrogen and compressed under a magnetic field! The neutron count, and duration of the release, and the time of the release after treatment all fluctuated considerably. Neutron emissions were observed in ten out of ten test cases. Normal hydrogen alone yields no neutrons." (Infinite Energy, Vol. 10, Issue 56, July/August 2004, p. 37,38; 39; Tadahiko Mizuno, Himoro Kenichi, Francesco Celani, "Neutron Emission from Low-Temperature D₂ Gas in a Magnetic Field")

One field that needs intense and immediate investigation is the electrolytic neutralization of high-level radioactive waste, a process that I have called "the profitable destruction of energy" ☺ . (Actually, the indications are that such a process would produce energy, as well as tons of valuable non-radioactive metal-rich sludge that could be processed by a mining company.) Neutralization could be done on-site at the nuclear power plant. This would be far safer than transporting tens of thousands of tons of highly radioactive waste from sites all over the country to a very expensive storage facility like that planned for Yucca Mountain, Nevada. Furthermore, storing the waste does not actually get rid of it. A storage facility will still have to be monitored for thousands of years. On-site neutralization is by far the most sensible, safest, and least expensive alternative. (See also [Brian Fraser's Adventures in Energy Destruction](#) .)

"Science progresses funeral by funeral."
"A new scientific truth does not triumph by convincing its opponents and making them see the light, but rather because its opponents eventually die, and a new generation grows up that is familiar with it."
Max Planck, *A Scientific Autobiography*, translated by Frank Gaynor, 1949, p. 33

Evidence for Equivalence of Thermal Space and Electron Space

The [article above](#) suggested that there is a kind of equivalence between the phenomena of moving mass through space and moving electrons through a mass. It also pointed out that the energy equations take the same form. In effect, heating up a mass causes more space to be added to the space/time ratio that we call mass. This will cause it to increase in volume (expand) as well as increase in temperature.

There are still other effects that suggest an equivalence between electron space (rotational) and thermal space (linear). Consider this note from electrochemistry:

"The electron flow from one electronic conductor equals the inflow to the other; that is, *a purely chemical reaction* (one not involving net electron transfer) *can be carried out in an electrochemical cell*. Such net reactions in an electrochemical cell turn out to be formally identical to the familiar thermally induced reaction of ordinary chemistry in which molecules collide with each other and form new species with new bonds. . . . Thus, from an overall point of view . . . this net cell reaction is identical to that which would occur if one heated hydrogen iodide and produced hydrogen and iodine by a purely chemical, or thermal, reaction." *Modern Electrochemistry: Ionics*, Vol 1, John O'M. Bockris, Amula K.N. Reddy, 1998, second edition, p. 10-11 (*emphasis* is in the original text)

And consider that there is a Hall effect that applies to the deflection of heat by a magnetic field:

"To test each crystal, Hirschberger attached tiny gold electrodes to either end of the slab, using microheaters to drive a heat current through the crystal. At such low temperatures, this heat current is analogous to the electric current in the ordinary Hall Effect experiment.

At the same time, he applied a magnetic field in the direction perpendicular to the heat current. To his surprise, he saw that the heat current was deflected to one side of the crystal. He had observed the Hall Effect in a non-magnetic material.

Surprised by the results, Ong suggested that Hirschberger repeat the experiment, this time by reversing the direction of the heat current. If Hirschberger was really seeing the Hall Effect, the current should deflect to the opposite side of the crystal. Reconfiguring the experiment at such low temperatures was not easy, but eventually he demonstrated that the signal did indeed reverse in a manner consistent with the Hall Effect." (<http://phys.org/news/2015-04-frustrated-magnets-reveals-clues-discontent.html> April 3, 2015)

The idea that the electron is rotational space is consistent with the insubstantial nature of electric current and the flow of heat (there is no motion of a "fluid" in the usual sense of the word). It also allows electrons to move at speeds comparable to that of light inside a wire and to be extremely responsive to ultra high frequency alternating currents. The idea that rotational space can move through matter, just as matter can move through open space, also suggests a different way to explain superconductivity at cryogenic temperatures. (The problem of explaining superconductivity is actually one of explaining *resistance*, not conduction.) See also: [E x B Motion Couplers](#)

Energy from massless particles?

The discussion of the [Atomic Spin System](#) showed that the periodicity of the Periodic Table is based on four integers: 1,2,3,4. The integers 2,3, and 4 are used twice each and account for two rows each in the Table. But the integer 1 is used only once, and accounts for only one row. This latter characteristic breaks the overall periodicity pattern. However, we found that the periodicity could be extended "backwards" and that when this was done, "less-than-atomic" (subatomic) particles were the result, and were all based on the integer 1. These

particles were all massless. They are of interest to us here because they may be involved in the characteristic phenomena of "cold fusion", namely, excess heat, anomalous power, and nuclear transmutations.

But first of all, what is a particle? For our purposes, a particle is a space/time (or time/space) ratio that is characterized by intrinsic rotation. Anything with what physicists call "intrinsic spin" is a particle. That includes familiar particles common to our environment like photons, electrons, neutrons, and atoms. It also includes their inverse space/time counterparts (anti-matter or mesons) which, from our standpoint, have strange properties like very short life-times and low mass, and which pass through our environment at the speed of light.

Besides intrinsic spin, space/time (or time/space) ratios can have another property of interest: intrinsic translation. Whereas intrinsic rotation is a change of direction, intrinsic translation is a change of position. It arises out of a property we could call "extensionality". This latter property has three independent ways of manifesting itself (three dimensions). Because the ratio has three dimensions, and because the ratio of space to time is a speed, we infer that space and time are coupled as a speed in three dimensions. We recognize this as the expansion of the Universe and the progression of time. Because space and time are extensible and involve multiple units, we can distinguish one from another. We have the ability to say that a particle is "here and not there" (in space or time). This leads to concepts of "location" and "separability". But if we reduce our view of space down so much that we can see only one unit, any identical particles "inside" this space cannot be distinguished from each other by their position in space. They can, however, be distinguished by another sort of relationship.

As I have explained in the article on [Advanced Stellar Propulsion Systems](#), time is three dimensional like space. A particle therefore has a position in coordinate time as well as in coordinate space. In general, locations in coordinate time would have no relationship to a location in coordinate space. But if all entities in the Universe are space/time (or time/space) ratios, then space and time never really occur in isolation. It is this coupling through a ratio that allows us to describe one in terms of the other. Such a description produces seemingly non-intuitive concepts like non-locality, non-separability and indeterminacy—properties that seem to be just opposite of the spatial ones. Such a description also requires mathematical tools that have "infinite reach" from the spatial standpoint. Hence, we end up using mathematical constructs like Schrödinger's wave equation, Heisenberg's infinite matrices, Feynman's infinite path integral method, the energy-based, non-trajectory description of the Hamiltonian, and so forth. These methods have only scalar contact with the spatial system and the magnitude thus available must be given an interpretation consistent with this limitation (such as a probability, or a distance, instead of a location).

The combination of a rotational entity moving linearly also results in "wave properties" from our perspective. The "inverseness" of the ratio leads to the Uncertainty Principle (i.e., greater certainty in one component requires less certainty in the other).

Well, now that you know what a particle is and how the Universe portrays them ☺, let's find out what sort of energy is associated with various types of particles. A good starting point is [Einstein's energy relation](#):

$$E^2 = (pc)^2 + (mc^2)^2$$

where E is energy, p is momentum, m is mass, and c is the speed of light.

Mathematically this equation looks like vector addition of two orthogonal components (remember the Pythagorean theorem from highschool trigonometry?). Taken separately, we see that $E = mc^2$ for massive particles (like atoms) and $E = pc$ for massless particles (like the neutrino and photon). We are of course interested in knowing the space/time dimensions of these terms. The dimensions of energy and mass were worked out in the [discussion of the Hamiltonian](#). The dimensions of p (momentum) can be worked out from

simple equations like $p = mv$, an expression for mechanical momentum. The space/time dimensions for each term are summarized in the following table:

Symbol	Name	Space/time dimensions	C Factor	Energy Term
E	energy	t/s	c^0	E
p	momentum	t^2/s^2	c^1	pc
m	mass	t^3/s^3	c^2	mc^2

Note that energy, momentum, and mass are *all* t/s terms raised to a power, and that as we go down the table the powers progress as 1, 2, and 3. We see that momentum could be viewed as energy in *two* dimensions, and that mass could be viewed as energy in *three* dimensions. We also see that there is a c factor, and that its exponent is dependent on the dimensional distance to the energy term. For instance, the ratio for energy has an exponent of 1 and the ratio for mass has an exponent of 3. The exponent for c to relate the two terms must be the difference, hence, c^2 . (we saw this before in the equation $E=cB$, where the electric field (one-dimensional) is related to a magnetic field (two-dimensional) by a factor of c).

A couple more formulas of interest are the de Broglie expression for massless momentum:

$$p = \hbar/\lambda$$

and the energy expression for a photon in terms of its frequency:

$$E = \hbar f$$

You will recognize \hbar and h as Planck's constant. Their usage is slightly confusing to the uninitiated. The constant \hbar (called "h cross" or "h bar") is actually $h/2\pi$. Its dimensions are those of angular momentum (in space/time terms that would be t^2/s^2) They are both called "Planck's constant" by physicists because to them it is usually obvious where to apply the 2π factor. The dimensions for the de Broglie expression ($p\lambda = h$) therefore are $(t^2/s^2)^s = t^2/s^2$. The dimensions for photon energy ($E=hf$) are apparently $t/s = (t^2/s^2) (1/t)$. The reason for the "1" in the numerator instead of "s" is not clear. Everything in this scheme is supposed to reduce to a space/time or time/space ratio. Possibly, linear extensional space might not have the same representation as rotational space. Or it could just be that this scheme has some dimensionless numbers—just plain, ordinary counting integers. (revised 8-15-07)

You can see from the table that "massless momentum" is no more mysterious than mass or energy, and is in fact midway between them dimensionally. But if you are like most people, you still might not feel intuitively comfortable with this. The main problem seems to be that most people lack solid answers to the questions: What is mass? and What is inertia?

This was explained in fair detail in the article [Advanced Stellar Propulsion Systems](#). Mass is effectively an intrinsic spin system that moves "anti" to the outward expansion of the general progression of space/time. The latter tends to move entities to increasing spatial and temporal separation. Gravitation opposes this motion in all three linear dimensions in space. Hence, gravitating particles are moving together. The motion is caused by the intrinsic spin of the particle. Yes, I know that classically you cannot just add angular motion directly with linear motion. But in this case the motions are intrinsic. They are not motions *of* something, they *are* motions inherently. At this level, the Universe apparently does not distinguish between an intrinsic change of direction (spin) and an intrinsic change of position (translation). They are just magnitudes and can be added together

without any problem. If the Universe is expanding outward at the speed of light (c), then the intrinsic rotation has to move inward at twice the speed of light to achieve the motion that we call gravitation. Note that this implies a zero (a reference magnitude) for rotational motion. Note that it also implies that a factor of c will appear in the various equations of physics that describe fundamental phenomena as seen from a gravitationally bound system like the one we inhabit.

Out of this comes an explanation for inertia. I have two ways of explaining inertia to people. The first is easy to grasp (literally) but slightly misleading at first. But let's try it. Hold a toy gyroscope in your hand. You'll notice that as long as the rotor is not spinning, you can move the "dead" gyro just like any other object, say a book. You can move it translationally or rotationally and there is nothing unusual about it. You could put it in a small box (say a lunch box) and you would not be able to tell whether there is a "dead" gyro or a book in the box. But when you spin the rotor up to a fast speed, the behavior of the gyro becomes quite different from that of a book. The gyro acquires angular momentum, and this momentum resists a change in direction. You will have no trouble moving the gyro translationally, but you will find that it resists being turned in a plane that is perpendicular to the plane of the rotor. If you put this spinning gyro into the lunch box, you could easily tell whether the box has a book or a gyro in it. In fact if you were to give such a box to someone who knows nothing about gyros, it would seem to have very strange properties!

The spin on the gyro has nothing to do with the intrinsic spin of atoms. This kind of spin is a thing *with* a spin, not an intrinsic spin itself. The point of the illustration is that we could say the spinning gyro has a kind of inertia: inertia of direction (this is not a term physicists use ☺) It resists being turned, even though it seems to be stationary. What we are really trying to understand is the more usual kind of inertia: inertia of translation.

So let's try the second illustration. Picture a garden hose with a fast stream of water issuing out from a nozzle. If you touch this stream with your finger, you'll find that it is stiff ("a stiff stream of water"). If you slow down the flow, you will find that it can be more easily deflected. The stream has momentum and it resists a change in direction, even though it is not rotating. Let's say now the nozzle is changed to a special type that sprays a disk of water instead of a stream. If the water was moving fast enough, we could probably bounce a toy ball off this disk. The momentum is now operative in two dimensions instead of one, and again resists a change in direction, even though it is not rotating.

We cannot stretch this illustration any further and so at this point we'll have to switch to atoms with intrinsic spin. These too have momentum. They are moving linearly at the speed of light (the motion is "anti" to the outward expansion of space). They too will resist a change in direction. But atoms are moving, not just in one dimension, but in all three simultaneously (gravitational motion). Consequently, they resist a change of direction in *any* direction. And like the gyro-in-a-box, the atoms seem to be stationary and motionless. We humans have the same type of motion and so these atoms seem to "stay put" like everything else around us, even though it is all moving inwardly at the speed of light, like everything else on the planet. It is this resistance to a change of motion that we call inertia. Thus, inertia is really just a fundamental type of momentum, but it operates in three dimensions instead of two.

So now you should have a better feel for massless particles (neutrino class). They are intrinsic spin systems just like atoms, except that they are not quite atoms, and lack one dimension of the gravitational motion. The "unoccupied dimension" can, of course, take any orientation relative to our environment. Consequently, massless particles always move at the speed of light relative to a gravitationally bound system. Their motion at the speed of light, regardless of their energy, creates a problem for physicists because massless particles of different energies can take the same trajectories and can be distinguished only by their momentum, not by their speed or paths.

The inherent energy of a mass~~less~~ particle will be less than that for a mass~~ive~~ particle by a factor of c as explained above. Still, this is pretty energetic. And this type of energy might be easier to tap into because of a simpler spin system. The electron and positron have one-dimensional spins and can annihilate on contact. The

complex spin systems of atoms, on the other hand, cannot align in such a way as to annihilate and so atomic combinations are quite stable. Massless particles are somewhere in between these extremes. If they can annihilate, they might not do so instantly, but could have a considerable half-life as a metastable association. Such an association would ultimately have one of two possible outcomes. Either the combination will produce energy or it will produce mass. There is not enough "stuff" to produce both. Hmmm . . . that is beginning to sound like the "cold fusion" experiments.

The true signature of these experiments was excess heat or anomalous power. Such phenomena acquired an indisputable factual basis by about 1995 (at least for anyone who actually looks at the evidence). The underlying cause of this excess power is not known and has been the subject of intense research and speculation for several years. The energy densities are so high that there is no way to explain the power chemically (a postage stamp sized piece of palladium foil can produce as much energy as a 60 ampere-hour car battery or enough energy to turn a kitchen electric spiral burner cherry red for more than twenty minutes). Hence, researchers have felt that some form of "nuclear energy" is involved. But there were essentially no neutrons, and no deadly radiation that customarily accompanies such nuclear reactions. The whole thing just seemed to be too perfect: abundant atomic power without the mess and hazards of conventional nuclear reactions!

Later, nuclear transmutation products were found in the electrodes from the electrolytic cells. These were non-radioactive materials like iron, chromium, copper, tin, titanium, platinum, and lead where none had existed before. They had a non-natural ("anomalous") isotopic composition and were present only in electrodes that had been run in cells that produced excess heat. ("Isotopic Anomalies Reveal LENR Insights", Steven B.

Krivit, <http://newenergytimes.com/v2/news/2010/35/SR35906insights.shtml>) It was also discovered that the radioactivity of materials like thorium and uranium could be neutralized by an electrolytic cell. These too would produce non-natural isotopic distributions of metals like copper and titanium, along with the disappearance of the uranium and thorium, but there was no appreciable excess heat. It seemed that the experiments could be configured to yield one or the other, but not both.

Furthermore, a "heat after death" phenomena made its appearance early on. After a cell that was producing excess heat was turned off electrically, it would continue to produce excess heat (lots of it!), even after it evaporated all the electrolyte. *Something* energetic seemed to have a finite lifetime in these cells. The appearance of anomalous power after the cells had been turned off raised serious concerns about how to control scaled up versions of these cells.

The institutional physics community was saying that these researchers were claiming to get "something from nothing" and that such claims violated the well established Conservation of Energy/Mass principle, which no physicist in his right mind would give up without extremely compelling evidence. But if you remember your physics history, scientists had a problem like this before. There is a radioactive phenomenon called beta decay. The overall reaction has a definite energy, but the beta rays showed a *spread* of energies. This seemed to violate the Conservation of Energy principle and to get around this awful problem, Wolfgang Pauli proposed in 1930 that the "missing energy" was being carried away by a massless, uncharged particle that was essentially undetectable. Scientists did not feel comfortable at first with the proposition that there was a particle that could not be detected, and which existed for only one special purpose. But we know this particle today as the *neutrino*.

So when I hear "something for nothing" and "violation of Conservation of Energy" I naturally think of "massless particle". But it is not just the neutrino. According to the presentation on [Atomic Spin Systems](#), there are apparently five such massless particles: the electron, positron, neutrino, massless neutron, and an Unnamed Particle. One or more of these are probably involved in the production of the "excess heat". But my view is that they seem to be mediators in a conversion process, not the actual source of the energy.

Remember that problem with massless particles? Massless particles don't "stay put." They always move at the speed of light, at least when in free space. They are not going to linger in an electrolytic cell for minutes or days or a couple of months (as seems to be required by these experiments). We need to discover the rules that govern the movement and "identity maintenance" of massless particles.

We could start with the photon. The photon can retain its identity after traveling through millions of light years of space. Ordinary light can also travel through a transparent solid like glass and emerge intact. Some materials are not transparent to ordinary light, but are transparent to light of other frequencies, say infrared or X-rays. From this we could infer a general clue: light needs an open dimension for its rotational system and another open dimension for its linear motion to persist as light. If it does not have both, the light will be stopped and will be forced to release its energy. The photon will lose its identity and cease to exist.

What about neutrinos? They interact extremely weakly with matter. "Such particles would pass through the sun with very little chance of collision. The thickness of Pb [lead] required to attenuate neutrinos by the factor $1/e \dots [0.37]$ is about 10^{20} cm, or 110 light-years of Pb!" (*The Atomic Nucleus*, Robley D. Evans, 1955, p. 547). Our Earth sees a continual flux of neutrinos, but most go right on through at the speed of light, and retain their identity as well. Apparently all materials have the required open dimensions for this particle, and that makes them very hard to work with. And of course, that is exactly the problem we are trying to solve!

What about the Unnamed Particle? Its spin system is more atom-like than the neutrino. Inside matter, such a particle would tend to merge its spin system with the atomic spin system, except that the additional spin complexity could delay such a merger for a significant amount of time. Eventually though, matter would absorb these particles, just as it does more quickly with positrons. Unlike electrons, they become scarce and inconspicuous. What is unknown, and likely relevant to the "cold fusion" experiments, is the question of whether or not hydrogen and the Unnamed Particle are interconvertible under certain conditions. The question arises because the stable isotope of hydrogen has a mass of only one a.m.u. instead of two, and this suggests a spin system that is slightly closer to a massless particle than would be expected.

What about electrons? My own view is that electrons can exist in a massless form and move through interstellar space just like photons or neutrinos. But when they hit something, the whole picture changes. Electrons seem to retain their identity in the new environment, but they also acquire a charge. The charge produces a small mass effect and allows the electron to come to rest in our environment and be manipulated by electric fields in a laboratory apparatus. What could be called "free electrons" are also found in metals, such as copper. These electrons (those inside a good conductor) seem not to be charged. Unfortunately, modern theory in this area is full of contradictions. The electrons in a copper wire must be tightly bound to a positive charge (the nucleus) to give an electrically neutral solid, but yet be extremely loose so that a mere volt or two can produce currents of thousands of amperes. Yet, such a wire does not bristle with static electricity:

"A wire is electrically neutral (to a excellent approximation at least) whether or not it is carrying a current. It exerts no Coulomb force on a charged particle in its vicinity."

"Another implication of the above analysis is that any departure from electrical neutrality of a current-bearing wire, as observed in its own rest frame, must be very small indeed, or else the electric force on a moving charge outside the wire would completely swamp the magnetic force." — *Special Relativity*, A. P. French, 1968, p. 234, 259

These electrons have a magnetic effect, but no electrostatic effect. Furthermore, a wire's resistance is inversely proportional to the cross-sectional area of the wire. If such electrons were charged, they would move to the surface of the wire and the behavior of the electric current would show different characteristics. We must conclude that there is such a thing as an *uncharged* electron, and that in a terrestrial environment, they are found, not in open space, but only inside conductors. (See [related information](#))

This leads to a suggestion that charge can control where a particle is allowed to move. An electron can move from a conductor into open space if it acquires a charge. Otherwise it is confined to a solid. Charge somehow alters the availability of open dimensions. (insulators, we will surmise, do not have the requisite linear or rotational open dimensions for electron motion, regardless of whether the electron is charged or uncharged)

That leads to the next question. What kind of particles can accept charges? The photon apparently cannot accept charges, nor can the ordinary neutron. But electrons, positrons, and atoms can accept charges. This leaves us wondering about the neutrino-class massless particle group, which is in-between these two groups. Presumably, the neutrino and the Unnamed Particle could accept a charge, but the massless neutron could not.

A negative charge on the otherwise featureless neutrino would make it act like an electron. A charged electron and a charged neutrino would almost certainly manifest differences in mass when in free space, but no such differences have been apparent to particle physicists. Of the two, the charged electron is the only one that exists observationally.

This leaves us with the default conclusion that if there is such a thing as a charged neutrino, it must exist only inside matter. There, it would be observationally equivalent to the electron, which would explain why physicists have not been able to identify it as a distinct and different entity. Its "open dimension" situation would be opposite to that of the electron. Motion in open space (the reference system) is available to the electron only if it has a charge, but motion in open space is available to the neutrino only if it does not have a charge.

This would be a very convenient conclusion for the "cold fusion" experiments. The neutrinos can "stay put" and would not fly off at the speed of light. The electric current in the electrolytic cells may involve both neutrinos and electrons. In space/time dimensions neutrinos are midway between mass and energy (see table above) and might be involved in a mass-to-energy conversion process. Not all "cold fusion cells" are electrolytic, however. Some, like ceramic proton conductors, operate at elevated temperatures (a few hundred Celsius). But as brought out in the note just prior to this article, electron space (rotational), thermal space (linear), and now neutrino space (rotational), may all be equivalent for these purposes.

The table (above) suggests that both massive and massless particles can be converted to energy. But the conversion process is not intuitively simple and obvious. Consider an example given in most textbooks on conventional nuclear physics. Helium is created by fusing two hydrogen atoms and two neutrons into a helium atom. A relatively large amount of energy (28.3 MeV per helium atom) is released in the process. Yet when we add up the mass of the starting materials and

compare that with the mass of the final helium atom, we are left wondering, what exactly, got converted to energy. The mass of two hydrogen atoms + two neutrons = $2 \times 1.0078252 + 2 \times 1.0086654$ or 4.0329812 atomic mass units (C^{12} basis). The mass of the final helium atom is 4.002603. Note that the end product, helium, is *less massive* than the total mass of the "parts" taken separately. The difference is 0.0303799 a.m.u. This so-called "mass deficit" appears externally as energy. The explanation, from the standpoint of nuclear theory, is that the helium atom is more stable than are the separate parts, and therefore requires less "binding energy" to hold the parts together. This now unneeded potential energy is cast aside into the environment and does not appear as mass in the helium atom.

What is so strikingly apparent in this situation is that most of the mass is accounted for, and has *not* been converted to energy, but has remained as mass. Only 0.7 per cent (i.e., $0.0303799 / 4.0329812$) of the mass of the starting materials is released as energy.

According to nuclear theory, atoms can be fused together and release energy provided the final product is less massive than iron (or more generally, iron, cobalt, or nickel). This is the so-called "fusion" process. It is also possible to split a massive atom apart and have it release energy, provided that the initial atom is much more massive than iron. This is the so-called "fission" process.

An example would be the symmetrical fission of uranium (${}_{92}U^{238}$). The average binding energy per nucleon (usually read from a graph in most physics textbooks) for this atom is about 7.6 MeV. A symmetrical split would produce two atoms of mass 119. These in turn have an average binding energy per nucleon of about 8.5 MeV. The difference in energy between the uranium and its fission products is thus $238 \times 7.6 = 1810$ MeV for uranium itself versus $2 \times 119 \times 8.5 = 2023$ for the fission products. That is a difference of about 213 MeV. The split takes the mass of the products downwards towards the iron group. The resulting less massive atoms are more stable than the large uranium atom. The unneeded "binding energy" is again cast aside into the environment and appears first as kinetic energy and finally as thermal energy.

Again, only a small fraction of the total mass is converted into energy. The full mass of the uranium atom has a mass, in energy units, of about 238×931.5 MeV. In symmetrical fission, a mere fraction ($213 / (238 \times 931)$) appears as energy. In this case, about one tenth of one percent of the mass of the (fissioning) uranium is converted to energy.

The mass unit that gets converted to energy is less than one percent of the ordinary mass unit (1 a.m.u or 931.5 MeV). For nuclear theory this does not present a problem, because the "binding energy" is just potential energy and is not quantized into units of atomic mass. But in my view, there are no "parts" to the atom, no binding energy is needed, and so the explanation used in the nuclear model is not available in this situation. Atomic mass seems to come in units of 2 a.m.u (primary mass) or 1 a.m.u (secondary mass). Now we seem to have a need for a very small mass unit, which is also "discardable" or "non-essential" in some sense, and which can apparently be positive or negative in magnitude when it is associated with an atom.

Could some type of charge meet these requirements? As things stand now, this seems to be an open question. The current belief in physics is that charge is another fundamental quantity like mass,

space, and time, but the fact that charges have no independent existence and are always found to be attached to something (an electron, an atom, etc.), seems to contradict this belief. Wherever they appear, they are always associated with an existing intrinsic spin system. That suggests the existence of electrical, magnetic, and mass effects depending on whether the charge is distributed in one, two, or three dimensions, respectively (or whether the charge itself is multi-dimensional). Charges can be transferred from one spin system to another (as in electrolysis) and can also be neutralized. And that, again, suggests an ability to transfer, as well as transform, small units of mass, and maybe even do it by electrical means.

It also seems that nuclear reactors, nuclear weapons, and the "cold fusion" experiments are *not* tapping into the type of power process that powers the stars. That process is based on whole primary mass units and is therefore hundreds of times more powerful, and much more difficult to initiate. We know of only two types of "atomic" power processes. As mentioned above, one is based on $E = mc^2$ and the other is based on $E = pc$. The one that mankind has been using, actually seems to be the latter and not the former.

One thing *is* clear. Easy access to atomic energy through simple means like electronuclear chemistry will yield both stupendous benefits as well as horrific consequences for our civilization.

"God chose the foolish things of the world to shame the wise; God chose the weak things of the world to shame the strong. He chose the lowly things of this world and the despised things—and the things that are not—to nullify the things that are, so that no one may boast before him." (1 Corinthians 1:27, *NIV*)

Ray guns, Nuclear Isomers, Rydberg Atoms

Hold out your hand and put a dime on the tip of your finger. An American dime weighs about 2.3 grams. Now imagine putting this same weight of a different and special material into a "ray gun". If you fire this ray gun, it will emit an extremely intense gamma ray pulse. The pulse will look something like a lightning bolt, except far more powerful. It will release the energy equivalent of two and one half thousand-pound bombs.

Sound far fetched? Scientists have been working on the basic technology during the last few years:

X RAYS IN, GAMMA RAYS OUT. A laser is a machine for pumping energy (electrical, light, chemical, etc.) into a medium (liquid, gas, solid, etc.) whose atoms subsequently relax in a concerted way, producing coherent light. One of the obstacles to creating an x-ray or gamma laser is the inability to pack enough energy into the medium and have it sit there long enough until it can be extracted under the right circumstances. One candidate medium for the job is isomeric hafnium. In nuclear physics isomers are nuclei that have the same number of neutrons and protons but differ in that for one nucleus one or more nucleons (protons or neutrons) are placed in an excited state. Physicists . . . begin with a sample (prepared at Los Alamos) of a metastable (31-year lifetime) isomer of Hf-178 with 4 participating nucleons, possessing a **stored energy of 2.5 MeV**. Then, like a transistor triggered by the merest of gate signals, the isomer material can, with the input of some x rays (amounting to only 1.6% of the output energy), produce induced gamma emission (IGE); thus x ray energy is stockpiled in the Hf and later extracted at higher gamma-ray energy. The emitted rays are not coherent, however, so this is not yet an example of gamma lasing. ([C.B. Collins et al.](#), *Physical Review Letters*, 25 January 1999)

For more articles see:

<http://www.utdallas.edu/research/quantum/cqeseg3.htm#TOPGAM>
<http://www.ehis.navy.mil/eurogram/marapr98/STICKLEY.HTM>

http://bric.postech.ac.kr/science/97now/99_1now/990127b.html

<http://www.cat.ernet.in/lasernews/ln991/ln991n05.html>

<http://web.nps.navy.mil/~library/bibs/dewtrc.htm>

"First Light for a Gamma Ray Flashbulb" (Science, Vol 283:769-770, 5 Feb 1999)

Superbomb ignites science dispute

Pentagon advisers challenge experiments behind nonnuclear weapon <http://sfgate.com/cgi-bin/article.cgi?file=/c/a/2003/09/28/MN23720.DTL>

"Isomer Wars", Laura Durnford, 27 October 2003

<http://www2.rnw.nl/rnw/en/features/science/031027isomer.html>

"Tapping the power of isomers", Laura Durnford (Hans de Vreij), 20 October 2003

<http://www2.rnw.nl/rnw/en/features/science/031020isomer.html>

"The Ultimate Laser", Ivan Amato, 27 Jan 1999

http://bric.postech.ac.kr/science/97now/99_1now/990127b.html

"Scary things come in small packages", Sharon Weinberger

(2004) http://www.utwatch.org/oldnews/wp_isomer_3_28_04.html

The energy storage capability for Hf-178 is reported variously as 1 billion joules per gram, 2.5 MeV per atom, and 0.05 exawatt per gram. What does that all mean in common terms? What is one billion joules? How much energy is in a gram of Hafnium at 2.5 MeV per atom? First, we go to a physics handbook and look up some conversion factors:

1 Joule = 1 watt-second

1 Kilowatt-hour = 3.6×10^6 Joule

1 MeV = 1.602×10^{-13} joule

1 kt TNT = 4.184×10^{12} J = 2.61×10^{25} MeV

Avagadro's number 6.023×10^{23} atoms/mole

For the one billion joules we have:

(1×10^9 J) ($1 \text{ kWh} / 3.6 \times 10^6 \text{ J}$) = 277.8 kWh

or about 556 kitchen toasters running for 1 hour

To convert that to tons of TNT we use the following:

(1×10^9 J) / (4.184×10^{12} J/kt)

= 0.239×10^{-3} kiloton

= 0.239 x ton

= 478 lbs. of TNT

And so now you know how to convert the kilowatt hours on your electric bill to TNT equivalents! ☺ But what does the 2.5 MeV per atom come out to?

atomic wt Hf¹⁷⁸ = 178

number of atoms in 1 gram Hf¹⁷⁸ = 6.023×10^{23} atoms/ 178

$$= 3.38 \times 10^{21} \text{ atoms/gram}$$

$$\begin{aligned} &\text{total MeV per gram at 2.5 MeV per atom} \\ &= 3.38 \times 10^{21} \text{ atoms/gram} \times 2.5 \text{ MeV/atom} \\ &= 8.46 \times 10^{21} \text{ MeV/gram} \end{aligned}$$

$$\begin{aligned} &\text{TNT equivalents} \\ &= (8.46 \times 10^{21} \text{ MeV}) / (2.61 \times 10^{25} \text{ MeV/kt}) \\ &= 3.24 \times 10^{-4} \text{ kt} \\ &= 0.324 \times 10^{-3} \text{ kt} \\ &= 0.324 \text{ tons TNT} \\ &= 648 \text{ lbs. of TNT} \end{aligned}$$

So we could say, roughly, that the energy in one gram of the "charged up" isomer of Hf^{178} is the equivalent of about 500 lbs. of TNT. A 1000 lb. General Purpose aerial bomb has an explosive content of about 555 lbs. (and, in case you are interested, about 20% of the explosive power is expended in shattering the steel case). A dime weighs about 2.3 grams. So our hypothetical ray gun would emit a gamma ray burst into the atmosphere with energy greater than that of a 2000 pound aerial bomb. You would NOT want to hold this thing in your hand and pull the trigger when it is set on ANNIHILATE!

And what about the 0.05 exawatt? All it means is that the energy can be emitted extremely quickly, even faster than light from a flashbulb. It does not just dribble out over a period of time like light from a flashlight (0.5 watt). A 134 horsepower automobile engine can deliver energy at the rate of 100 kilowatts (100 kJoules per second). An exawatt is 10^{18} watts, or a billion billion watts. So that represents extremely fast energy delivery!

Also, note the distinction between an isotope and an isomer:

nuclear isotopes: These are atoms that have the same atomic number (and therefore the same chemical properties), but different mass. Nowadays, they are in the news a lot over concerns about nuclear waste, dirty bombs, contamination with "radioactive iodine", cesium 137, strontium 90, etc.

nuclear isomers: These are atoms that have identical mass and atomic number, but different energy states. They decay by emission of gamma rays (usually). You rarely see references to them in popular literature. In the *Handbook of Chemistry of Physics*, they are listed in the isotope tables and have an *m* after the mass number.

atomic isobars: These are atoms that have identical mass but different atomic number. You will hardly ever see references to them by this term.

Nuclear isomers are usually quite unstable from our standpoint. They quickly emit gamma rays and go to the ground state. But they are slightly long-lived from the perspective of the atomic world and so they are called "metastable". Some unusual ones like Hafnium 178m, have a half-life measured in years. Tantalum 180m has an unusual distinction in that its metastable isomeric state has a half-life of over one thousand trillion years:

... Ta-180m carries a dual distinction. It is the rarest stable isotope occurring in nature and it is the only naturally occurring exawatt material. The actual ground state of Ta-180 is 1+ with a halflife of 8.1 hours while the tantalum nucleus of mass 180 occurring with 0.012% natural abundance is the 9- isomer, Ta-180m. It has an adopted excitation energy of 75.3 keV and a halflife in excess of 1.2×10^{15} years. <http://www.utdallas.edu/research/quantum/cqeseg3.htm>

Well, you have probably guessed that I am really not trying to write an article about ray guns. Rather, my intent here is to offer some insights into atomic structure in a way that is accessible and interesting to a general science audience. Studies on nuclear isomers show that the nucleus has a

shape. Normally, the shape of the nucleus is pretty much spherical. But in the case of nuclear isomers, it is deformed into a football (or water melon) shape:

Energy traps in atomic nuclei

PHILIP WALKER AND GEORGE DRACOULIS

A small proportion of atomic nuclei can form highly excited metastable states, or isomers. Of particular interest is a class of isomers found in deformed axially symmetric nuclei; these isomers are among the longest-lived and have the potential to reach the highest energies. By probing their properties, insights into nuclear structure have been gained. The possibility of stimulated isomer decay may ultimately lead to new forms of energy storage and γ -ray lasers. (*Nature* 399, 35 - 40 (1999) © Macmillan Publishers Ltd.)

"Hyperdeformed nuclei even more distorted than superdeformed nuclei have been found in recent experiments at Lawrence Berkeley Laboratory. When two medium-sized nuclei collide off-center, they can fuse into a highly-spinning, distorted nucleus which then sheds its rotational energy by emitting a series of gamma rays. In the past few years, researchers have found numerous examples of superdeformed nuclei, football-shaped particles with a 2-to-1 long-to-short axis ratio. But in recent experiments at LBL's 88-Inch Cyclotron, even more oblong (3-to-1) nuclei have apparently been produced. . . . One might expect such highly spinning nuclei to fragment immediately into two smaller pieces. Instead, a very small fraction of the hyperdeformed nuclei remain intact and merely get rid of their spins by emitting gamma rays. "(D.R. LaFosse et al., to appear in *Physical Review Letters*, 26 June 1995.) <http://newton.ex.ac.uk/aip/physnews.230.html#1>

"The predominate decay mode of excited nuclear states is by gamma-ray emission. The rate at which this process occurs is determined largely by the spins, parities, and excitation energies of the decaying state and of those to which it is decaying. In particular, the rate is extremely sensitive to the difference in the spins of initial and final states and to the difference in excitation energies. Both extremely large spin differences and extremely small energy differences can result in a slowing of the gamma-ray emission by many orders of magnitude, resulting in some excited states having unusually long lifetimes and therefore being termed isomeric. . . . Some excited nuclear states represent a drastic change in shape of the nucleus from the shape of the ground state. In many cases this extremely deformed shape displays unusual stability. . . . The possibility that nuclei may undergo sudden changes of shape at high rotational velocities has spurred searches for isomers with extremely high spin which may also be termed shape isomers." ("Nuclear Isomerism", McGraw-Hill Encyclopedia of Physics, 2nd ed., 1993, p. 892)

See also:

"Cranked Nuclei" <http://www.aip.org/png/2006/274.htm> , <http://www.aip.org/pnu/2006/split/807-2.html>

"Atom's core gets pear-shaped", Andrew

Grant http://www.sciencenews.org/view/generic/id/350258/description/Atoms_core_gets_pear-shaped

<http://en.wikipedia.org/wiki/Yrast>

<http://lateralscience.blogspot.co.uk/2012/07/phosphorescent-minerals-electrical.html>

This picture is consistent with the intuitive model of the atom that I have proposed elsewhere (see [The Atomic Spin System](#)). It consisted of two 4π rotation systems (two *two-dimensional* intrinsic spin systems) and one 2π rotation system (one *one-dimensional* intrinsic spin system). Because the 4π spin system is two dimensional, and not one-dimensional like the 2π system, it can accommodate high energy (consistent with gamma rays) in a tiny location. A working hypothesis here is that the gamma ray photons acquire an additional rotation (possibly temporal), and this gives them a gravitational-like motion which allows them, in effect, to stay "attached" to the atom. But gamma rays, like all photons, consist of a pair of *one-dimensional* rotations (2π) whereas the "nucleus" consists of a *pair* of *two-dimensional* rotations (4π). This association therefore does not have the characteristic stability of atoms in the non-isomeric state, and the trapped gamma rays can "de-rotate" and resume their journey as free photons.

The single 2π atomic rotation can likewise trap photons, but they are of much lower energy (in the microwave, instead of gamma ray, range). And, as you might expect, there is a change in the size of the atom (huge in this case). This is easily seen in what are called Rydberg atoms. They are atoms that have been given some additional energy (principle quantum number, n, around 30 to 50) but which remain below the first ionization level. Here is a quick sketch presented in terms of the nuclear model of the atom:

The preferred internal energy state of a cold atom is the state with the lowest energy (i.e. the ground state). Laser radiation can promote the atom to higher-energy states, or even remove the electron altogether by the process of photoionization. High-energy states, in which the electron is barely bound, are known as Rydberg states, and these have many remarkable properties. For example, the electron is very far from the nucleus.

If we label each state by its principal quantum number n , where n is large for Rydberg states, then the characteristic radius of the electron's orbit around the nucleus scales as n^2 , increasing from ~ 0.05 nm for the ground state to over 100 nm for a state with $n = 50$. The size of such an atom is comparable to the smallest feature on a modern integrated-circuit chip.

In contrast, the energy needed to remove the electron from the atom scales as $1/n^2$, decreasing from several electron-volts for the ground state to about 5 millielectron-volts for $n = 50$. Due to their small binding energy, Rydberg states tend to be very fragile and sensitive to external perturbations such as collisions or electric fields. ("Ultracold plasmas come of age", Physics in Action: March 2001 <http://physicsweb.org/article/world/14/3/3>)

And:

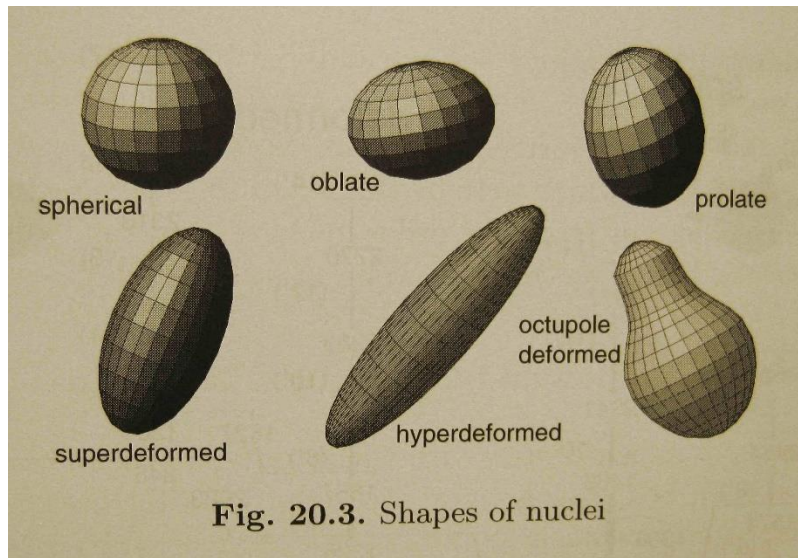
From the birth of quantum theory in 1925 to this day . . . a universally satisfactory reconciliation of quantum theory with classical physics has yet to be discovered.

Recently experimentalists have joined the quest by opening a new window on this forbidding territory. The focus of their attention has been a class of objects known as Rydberg atoms, named after nineteenth-century Swedish physicist Johannes Robert Rydberg. These are ordinary atoms in which the outermost electron has been promoted to an immensely large orbit. (To gain some idea of just how large that orbit is, you may imagine that by analogy, a Rydberg solar system would look like the real one, except that Pluto would somehow have been pushed out a thousand times farther from the sun than it is now.) Rydberg atoms occur in nature, but they are extremely delicate--even a small disturbance can tear the distant electron from its orbit and leave behind the positively charged rump of the atom (the ion). ("The Philosopher's Atom", Hans Christian von Baeyer, Discover Magazine, November 1995, <http://www.discover.com/archive/index.html>)

Rydberg atoms are so big that they are at the boundary that separates the quantum world from the classical world. The boundary appears to be about the same size as [one Natural Quantity of space](#) and therefore might offer an additional clue about how to determine this magnitude. In my view, all physical entities are space/time ratios. Neither the space nor time in that ratio can go below one unit. When the spatial portion becomes one unit, all further variation must be in time. Viewing this temporal behavior from a spatial reference system is what gives the quantum world its characteristic weird behavior. The Rydberg atom is right on the edge, and that is what makes its technical properties so interesting.

Also note that the addition of energy causes the size of the atom to increase, just as it did in the case of the "nucleus" with nuclear isomers, except in this case the one-dimensional spin system cannot store the energy in a form that is as compact as a two-dimensional spin system. Hence, Rydberg atoms are huge.

In summary, the existence of nuclear isomers, Rydberg atoms, and the words that nuclear physics uses to describe them (size, shape, spin) suggest that an intuitive model of the atom can be based on combinations of intrinsic rotation (a space/time ratio that is a change of direction instead of position, and which may be either spatial or temporal). A simple, clear model can lead to rapid advances in our knowledge of the atomic world and its application to modern technology. (See also [Some Thoughts about Intrinsic Spin](#), [The Photon Spin System](#), and [The Atomic Spin System](#))



Electrostatic Accelerators Fundamentals and Applications,
R. Hellborg (Ed.) (2005) p. 418

Links:

A Matter-Wave Interferometer for Large Molecules

Physics News Update, Number 579 #1

"this type of interferometer experiment will be useful in studying the borderland between the quantum and classical worlds."

<http://www.aip.org/enews/physnews/2002/split/579-1.html>

<http://physics.about.com/b/a/088912.htm> "Strontium-76 is one of the Most Deformed Nuclei"

Other:

"Warfare is changing as weapons that destroy electronics, not people, are deployed on the field of battle", Oct 15th 2011, <http://www.economist.com/node/21532245>

html 12/02a

Melted volume increases, but internuclear distance decreases. Why?

It is common knowledge that when a liquid cools and turns into a solid, there is usually a change in volume. Liquid water, for example, will expand when it changes into ice. Melted paraffin, however, will contract when it cools and turns into solid paraffin. This is easily seen by filling two small beakers with liquid water and melted paraffin. When they are each cooled to solidification, the water (ice) will have a slightly raised center (showing that it expanded) but the solidified paraffin will show a depressed or indented center, showing that it contracted. The pattern for most substances is that they expand when heated, and so the liquid is more voluminous (less dense) than the solid. Water is an obvious exception. So are the metals antimony and bismuth, which expand rather than contract when they solidify.

Regardless of what happens to the volume, we would at least expect one thing to always be true: if the substance expands, then the average distance between molecules (or atoms) should increase. If the volume gets smaller, then the average distance should decrease. Although this makes perfect sense, nature does not always accommodate our expectations. Crystalline potassium chloride (a common dietary salt substitute) when melted, will increase in volume some 17%. That the "fused salt" has greater volume than the solid crystal at the same temperature might not be a surprise to most people. But it *is* surprising that the average distance between ionic centers is 326 picometers for the solid form, yet only 310 for the liquid form. The liquid is *more* voluminous but has *smaller* distances between its atomic constituents. The distances are measured by X-ray and neutron diffraction.

The following tables illustrate this situation with some common ionic salts:

Table 5.9 Internuclear Distances in an Ionic Crystal and the Corresponding Fused Salt		
Distance between Oppositely Charged Ions (picometers)		
Salt	Crystal, m.p.	Molten Salt
LiCl	266	247
LiBr	285	268
LiI	312	285
NaI	335	315
KCl	326	310

Table 5.10 Volume Change on Fusion	
Substance	% Increase of Volume on Fusion
NaCl	25
NaF	24
NaI	19
KCl	17
CdBr ₂	28
NaNO ₃	11

(Partial tables from *Modern Electrochemistry: ionics*,
 John O'M.Bockris, Amulya K. N. Reddy,
 2nd ed, 1998, p. 611, 613)

The authors are themselves puzzled by this:

"There is another important fact about the melting process. When many ion lattices are melted, *there is a 10 to 25% increase in the volume of the system* (Table 5.10). This volume increase is of fundamental importance to someone who wishes to conceptualize models for ionic liquids because one is faced with an apparent contradiction. From the increase in volume, one would think that the mean distance apart of the ions in a liquid electrolyte would be greater than in its parent crystal. On the other hand, from the fact that the ions in a fused

salt are slightly closer together than in the solid lattice, one would think that there should be a small volume decrease upon fusion. How is this emptiness—which evidently gets introduced into the solid lattice on melting—to be conceptualized?" (*Modern Electrochemistry: ionics*, John O'M. Bockris, Amulya K. N. Reddy, 2nd ed, 1998, p. 611-612)

"Such "volumes of nothingness" must be present to account for the large increase in volume upon fusion while at the same time the internuclear distance decreases (see Tables 5.9 and 5.10)" (Bockris, *ibid.*, p. 619)

". . . this space is counterintuitive to the internuclear distances given by X-ray or neutron diffraction. The internuclear distances found in molten salts are smaller, not bigger, as might be thought from the increase in volume." (Bockris, *ibid.*, p. 620)

Explanations are offered for this difficulty, but they seem to boil down to little more than a restatement of the problem in terms that make it look like a solution.

I am interested in this problem because I seek answers to the following questions:

1. Does this behavior shed any light on the equivalence of thermal space and electron space [discussed above](#)?
2. Does the "metric coupling" between the quantum world and our world change at the melting point? (Is a rotational dimension changing into a linear dimension, thereby creating more volume, but reducing the measured interatomic distance?—or something like that)
3. Is this behavior a property of the aggregate, or a property of the atoms individually? Should we be speaking of "aggregates of melted atoms" or "melted aggregates of (unchanged) atoms"? Does something basic and fundamental about the atom (or molecule) change abruptly at the melting point? Or does the aggregate simply "jiggle itself apart" due to thermal motion (the current view)?

Other articles that may be of interest:

<http://physicsweb.org/article/news/7/10/8>

New conductor stands the heat

15 October 2003

"Mercouri Kanatzidis and colleagues at Michigan State University have discovered that a non-composite material made of ytterbium, gallium and germanium can also exhibit zero-expansion behaviour. Moreover, the new compound conducts electricity, whereas previous zero-expansion materials were insulators. Furthermore, the effect is observed over a wide temperature range - between 100 and 400 Kelvin."

html 11/03

Melted *atoms* or a melted *aggregate*?

The previous article has raised a question about whether the phenomenon of *melting* is a property of atoms and molecules individually or a property of the aggregate as a whole. Asked differently, do *atoms themselves* have a state called solid, liquid, gas? Or should solid, liquid, and gas be terms that describe the state of the *aggregate* (the relationships *between* constituent atoms or molecules)?

The concept of "liquid atoms" probably sounds kind of silly to many physicists. But we think of a *plasma* as a collection of ionized *atoms*. Along the same line of thought, might a liquid be a collection of "liquid atoms" (or liquid molecules)?

What about other properties, like the Curie point? That is the one, remember, where you hang the ball bearing from a magnet, then heat the ball bearing up with a blowtorch, and when the ball reaches the Curie point, it loses its magnetic properties and drops off. Is the loss of magnetism best explained by changes intrinsic to the atoms themselves, or by changes in the aggregate (the relationships between atoms)?

What about the concept of critical temperature? This is "the maximum temperature at which a gas (or vapor) may be liquified by application of pressure alone. Above this temperature the substance exists only as a gas." (*Van Nostrand's Scientific Encyclopedia*) Again, the concept of an atom that is intrinsically in a "gaseous atom" state seems quite viable here.

Ordinary evidence suggests that "liquid atoms" and "solid atoms" could coexist together. A textbook example is what happens when small blocks of lead and gold are left in contact with each other for a long period of time. When they are finally separated, it can be seen that some of the gold has migrated to the lead block and some of the lead has migrated to the gold block. Again, this is consistent with the idea of "liquid atoms" (mobile atoms) existing in a lattice of mostly "solid atoms".

According to this concept, during melting, an aggregate starts out with mostly "solid atoms". As the material is heated, more atoms transition to the "liquid atom" state. When these predominate over the "solid atoms", the aggregate falls apart (melts). It now has chunks of "solid atoms" floating around in a sea of "liquid atoms". As the temperature is raised still further, all the atoms eventually enter the "liquid atom" state. This would mean that the aggregate is intrinsically liquid in this condition; application of pressure alone cannot turn it back into a solid. In this respect it would be like the critical temperature for a gas, which cannot be liquified if it is above its critical temperature.

There are some tantalizing hints that the liquid/solid states of matter might behave in accord with such a concept.:

GALLIUM CLUSTERS ARE TOO SMALL TO MELT. Nanoscopic clusters of gallium atoms, consisting of as few as 17 atoms, melt at much higher temperatures than bulk gallium, according to recent research at the Indiana University. The observation runs counter to theoretical expectations of melting points for small clusters. In fact, current theory suggests that the melting point should fall as a cluster size is reduced, and that nanoscopic lumps of many materials should be liquid at room temperature. In previous work, the researchers (Martin Jarrold, 812-856-1182, mjf@indiana.edu) discovered similar trends in the melting of tin clusters, but did not observe melting transitions directly. Instead they monitored the shapes of small clusters to determine their state. In the recent experiment, the researchers launched the gallium clusters through a high pressure collision cell where they were heated in collisions with a helium buffer gas. By monitoring the portion of dissociated clusters that exited the collision cell, the researchers could directly determine the clusters' melting temperatures. While bulk gallium melts at 303 K, thirty-nine and forty atom gallium clusters melt at about 550 K, and seventeen atom clusters show no sign of melting at temperatures as high as 800 K. No theoretical framework currently exists to explain the high melting temperatures of gallium clusters. The researchers explain that their measurements may have important implications for nanotechnology and material science. In particular, nanoscopic clusters may not sinter at low temperatures if they don't melt as predicted by established theory. (G. A. Breaux et al., Physical Review Letters, 31 October 31) —PHYSICS NEWS UPDATE, The American Institute of Physics Bulletin of Physics News, Number 661 November 11, 2003 by Phillip F. Schewe, Ben Stein, and James Riordon

One thing that is apparent here is that the melting point of the *aggregate* and the melting point of the *atom* would not necessarily be the same thing. This may require two different concepts of what defines "melting".

I tried to investigate this idea and was surprised to find out how little is really known about the liquid and solid states:

"there is no generally accepted theory for melting in three dimensions (3D) at an atomistic level. . . . after millenia of metallurgy and common observation, there are empirical rules, some mean field theories, and some more microscopic theories, but it is fair to say that the problem remains poorly understood." <http://consult.ccs.ornl.gov/1pg/Melting.html>

"No comprehensive theory for the melting points of materials has ever been proposed. The best thing we have is a "rule" that was devised by F. A. Lindemann in 1910.³ Lindemann was inspired by the recent publication of Einstein's theory on the heat capacity of materials" (Melting of Plutonium: Learning from Neutron Diffraction, <http://lansce.lanl.gov/research/cond-matter/lawson.htm>)

Some years ago I thought experiments that could shed light on this issue would be relatively easy to perform. Find a solvent/solute system such that the behavior of the heat capacity of the system could be investigated as the temperature was swept upwards through the melting point of the solute. The ideal solute substance would have a fairly large change in heat capacity at its melting point, and the solvent should not have a boiling point (or freezing point) near the temperature of investigation. Once the substance is dissolved (solute), it no longer exists as an aggregate. If there is any abrupt change in heat capacity (or even a heat of fusion effect) at the melting point of the (dissolved) substance, then it must be due to changes in the properties of the molecule, not the aggregate.

Heat capacity should be fairly easy to measure. A small constant flow pump could feed a small tube equipped with an inlet thermocouple, a resistance wire that serves as an electrical heater, a turbulent flow section, and an outlet thermocouple. Heat capacity can be calculated from flow rate, inlet temperature, heat input, and outlet temperature. Heat capacity is normally somewhat temperature dependent, but all that is needed is an indication that the heat capacity undergoes a somewhat abrupt change at the melting point of the solute—one that is not seen in a system using pure solvent. For that matter, if you have access to a good chemical/chemical engineering library, you can probably find all the information you need just by consulting some tables and illustrations of heat capacities for suitable solvent/solute systems.

Unfortunately, the experiment with gallium described above suggests to me that things are not this simple. I would be interested in any thoughts or observations readers may have on this issue.

Also, I must leave open the possibility that melting could be achieved by non-thermal means, a process that would probably be called "electronic melting". For example, it might be possible to "melt" tungsten, nickel, platinum, carbon, etc. *at room temperature* and mix them all together *as liquids* and easily produce a "metallic glass" or some as-yet unimagined superalloy. (See also [./qmconcpt.htm#LiquidStateInduction](http://qmconcpt.htm#LiquidStateInduction))

And while we are on that subject, consider this:

"Most glassy forms of matter experience a gradual increase in heat capacity -- the amount of energy it takes to heat a sample by one degree Kelvin -- until a key transition point is reached. At that point (called the "glass temperature"), these materials suddenly up-jump to a new, 100 percent higher, heat capacity zone and change from a solid to very viscous liquid phase -- as if a solid brick of cold honey were heated and suddenly became a sticky liquid again. This occurs even in solutions in which water is the chief component.

In pure water, however, something quite different happens. As cold, glassy water is heated, its heat capacity barely changes until about 136 K (-215 F), where it begins to increase slightly. Then, abruptly at 150 K (-190 F), it crystallizes and stops being glassy. Approached from the other direction, supercooling water produces a similarly odd effect: Heat capacity remains constant as the water cools until around 250 K (-10 F), when it begins to increase very rapidly with decreasing temperature." ("New Clue In The Mystery Of Glassy Water", ScienceDaily (Jan. 31, 2008) <http://www.sciencedaily.com/releases/2008/01/080131151901.htm>)

Links:

"Using quantum mechanics to melt glass at absolute zero", <http://www.rdmag.com/News/2011/02/General-Science-Physics-Using-Quantum-Mechanics-To-Melt-Glass-At-Absolute-Zero/>

"Startling thermal energy behavior revealed by neutron scattering", Deborah Counce, June 22, 2011,
<http://www.physorg.com/news/2011-06-startling-thermal-energy-behavior-revealed.html>

"Sliding metals show fluidlike behavior, new clues to wear", Emil Venere (September 11, 2012)
) <http://phys.org/news/2012-09-metals-fluidlike-behavior-clues.html>

"Brownian motion in metal" <http://enews.lbl.gov/Science-Articles/Archive/MSD-Brownian-motion.html>

"Magic Sizes and Microscope Crucibles" <http://www.lbl.gov/Science-Articles/Research-Review/Magazine/1998/frontline/crucibles.html> ("With free nanoparticles the melting point may be as little as half that of the bulk material," says Ulrich Dahmen, head of the National Center for Electron Microscopy (NCEM), who discovered the "magic size" phenomenon while working with collaborators from the University of Copenhagen, "while a crystal embedded in a matrix of a different solid may need to be superheated to melt. This is like an ice cube refusing to melt in boiling water.")

html 1/05

[Return To Scriptural Physics Home Page](http://scripturalphysics.org/qm/issues.html)

<http://scripturalphysics.org/qm/issues.html>

Brian Fraser
REL-205, Sec. 1541
Religion and Modern Culture
Reflective Essay
Due: 3-22-2005

One Christian's Perspective on Quantum Mechanics

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Can the practice of biblical Christian principles be helpful in understanding the conceptual implications of Quantum Mechanics?

I believe the answer to this question is a resounding "Yes!" The Bible says nothing about Quantum Mechanics, of course, but it does set forth *principles* that are useful in the study of this subject. In this short paper I'll sketch some of those principles and then give an example of a conceptual insight that is very helpful for understanding Quantum Mechanics. But first, what is Quantum Mechanics?

"Quantum mechanics" is the description of the behavior of matter and light in all its details and, in particular, of the happenings on an atomic scale. Things on a very small scale behave like nothing that you have any direct experience about. They do not behave like waves, they do not behave like particles, they do not behave like clouds, or billiard balls, or weights on springs, or like anything that you have ever seen. . . . Because atomic behavior is so unlike ordinary experience, it is very difficult to get used to, and it appears peculiar and mysterious to everyone—both to the novice and to the experienced physicist. Even the experts do not understand it the way they would like to. . . . We know how large objects will act, but things on a small scale just do not act that way. So we have to learn about them in a sort of abstract or imaginative fashion and not by connection with our direct experience. (Feynman, R. P. Vol. 3, 1-1)

Answering this question from a biblical perspective is important. First, no satisfactory, generally accepted *conceptual* interpretation of Quantum Mechanics has ever been found, despite eighty years of intense debate and discussion of the subject. Any useful insight on this mystery, from whatever source, would be quite welcome.

Second, the science of Quantum Mechanics is itself important in our technological society. Advances in semiconductors, computers, communications, lasers, medical diagnostic equipment, and many other things depend heavily on its application. It is definitely something we need to understand.

Third, the question of the conceptual implications of Quantum Mechanics has never been given serious treatment in a biblical context. Christians have usually focused on issues like Evolution versus Creation, or on cosmology (the age and origin of the Universe, etc.). Indeed, these seem to be questions that could naturally and reasonably involve the Bible. But Quantum Mechanics?

Physics? If the Bible can somehow be legitimately applied in these fields, then we have much new territory to explore. Surely we will learn something important.

Physicist Feynman says that we have to learn about the behavior of atoms "in a sort of abstract or imaginative fashion and not by connection with our direct experience." Christians have the same sort of problem when learning about God. Fortunately, the Bible offers an important principle about perceiving the invisible:

"Faith is the substance of things hoped for, the evidence of things not seen. . . . The things which are seen were not made of things which are visible." (Hebrews 11:1-3, *NKJ*)

Biblically defined faith is clearly not just a belief based on blind credulity or trust in authority. It is based on evidence from actual, observable facts. The methodology used by Christians is thus very similar to that used by physicists.

Christians are also given an important clue about the Universe we live in:

"What may be known about God is plain to them, because *God has made it plain* to them. For since the creation of the world God's invisible qualities—his eternal power and divine nature—have been clearly seen, being understood from what has been made, so that men are without excuse." (Romans 1:19-20, *NIV*)

When correctly understood, the Universe is, at a minimum, supposed to be free of paradoxes and conceptual impossibilities. Additionally, we look for simplicity and elegance.

God even *invites* mankind to study his works:

"He seals the hand of every man, that all men may know His work. . . . Stand and consider the wonders of God. Do you know how God establishes them?" (Job 37:7, 14-15)

Christians are also practiced at sorting out conflicting information:

"Examine everything carefully; hold fast to that which is good." (1Thes 5:21)

"Do not be carried away by varied and strange teachings" (Hebrews 13:9)

"Test the spirits to see whether they are from God; because many false prophets have gone out into the world." (1John 4:1-3)

So here is our task: formulate a simple concept that can be inferred from factual evidence which can explain the conceptual difficulties of Quantum Mechanics.

One such concept could be what I call "temporal motion." It differs from ordinary spatial motion in that the motion is in coordinate time (time with three dimensions) instead of coordinate space. When you roll a marble across your desk, you are seeing an example of spatial motion. It has a starting point, an end point, and a trajectory that connects the two. But if you could impart *temporal* motion to an object, instead of *spatial* motion, what sort of picture would you see then?

Temporal motion, by definition, is not motion in or through space. Hence, from the spatial standpoint, and from our common way of thinking, it is necessarily some sort of "motionless motion."

Furthermore, temporal locations are "non-local" or "de-localized" in a spatial reference system. A location of 12 o'clock in the kitchen is also 12 o'clock in the living room. Locations in time appear anywhere/everywhere in space. Motion from one point in coordinate time to another point in coordinate time would be "trajectory-less" and infinite in extent *as seen from the spatial standpoint*.

Does anything act like that? Yes. Physicists are quite familiar with them. They call them "force fields." A gravitational force field is the simplest example. It is non-directional. That is, the force, or "motion" if we want to interpret the effect that way, is spherically distributed. It is motion that is "towards", but not towards any particular direction. It is also infinite in extent (at least out to the quantization limit). And, in and of itself, the effect has no path, no trajectory. It fits our strange description of temporal motion.

What does that have to do with Quantum Mechanics? Well, space and time are quantized. That means that atoms can approach each other no closer than one unit of space. With the spatial component of the motion fixed at one unit, any further motion must be in coordinate time. And that means temporal motion again. Which again means motion with no trajectory and which is infinite in extent. These are recognizable features of the mathematics of Quantum Mechanics.

The mathematics for Quantum Mechanics have "infinite reach." Schrodinger's wave equation has an infinite number of solutions, and requires the imposition of "boundary conditions" to get the particular solutions of interest. The same can be said of Heisenberg's infinite matrices, and of Feynman's "sum over all paths" method of Quantum Mechanics. Forces, velocities, and trajectories are generally not very useful in Quantum Mechanics. Instead, potentials and total energy are the quantities that are most useful (expressed in the so-called "Hamiltonian"). And these are clearly non-path, non-trajectory constructs.

So the picture that evolves is this: Newtonian Mechanics describes spatial motion. Quantum Mechanics describes temporal motion. Put the two together and all the mysteries, paradoxes, and conceptual difficulties that bother physicists can be made to disappear.

Here is a short list of what I think can be explained:

The EPR paradox: Two photons originating in the same event will separate in coordinate space, but not in coordinate time. An action imposed on one photon, will instantaneously produce a complementary action on the other photon, even though that photon might be light years distant (spatially) from the other.

Single photon interference: A single photon has a single spatial location and a single temporal location. The latter, however, has multiple incarnations of itself as seen from a spatial reference system (much like one's image in a house of mirrors). These effects combine to produce the "matter wave" interference pattern of Quantum Mechanics.

The nature of gravitation: Gravitation is clearly a temporal motion. A little thought will also show why it is an *accelerated* non-directional motion (a characteristic that causes us humans to be pressed against the Earth irrespective of our location upon it).

Why the gamma correction factor is used in Special Relativity: Solving the gamma equation for c , instead of for gamma, shows that temporal motion has an inverse and Pythagorean relationship with spatial motion.* In the truest, most complete descriptions of physical phenomena, *both* types of motion must be taken into account. (*meaning: $c^2 = c^2/\gamma + v^2$ where the dimensions are t/s for γ and s/t for v)

Issues in General Relativity that are clarified include the Shapiro time delay, gravitational lensing, gravitational redshift, gravitational time shift, the constancy of the speed of light, how Quantum Mechanics could be unified with General Relativity (which has so far been an intractable problem), and several lesser known issues in cosmology.

Now if all that can be achieved with the concept of *linear* temporal motion, we should ask, "What could be achieved with the concept of *rotational* temporal motion?" Such concepts might lead to exactly what NASA is seeking in its Breakthrough Propulsion Physics program. I hope other investigators, Christian or not, will pursue the implications.

We can now return to the original question: Can the practice of biblical Christian principles be helpful in understanding the conceptual implications of Quantum Mechanics? The answer is clearly, Yes! The Bible, of course, says nothing directly about physics or Quantum Mechanics. But it does say plenty about perceiving the invisible, about the Universe being accessible and understandable, about correct and careful reasoning, and about sorting through contradictory and confusing information. Christians become highly practiced in these methods and, as "mature men with minds trained by practice to distinguish between good and bad," they will find these skills useful in physics too. (Hebrews 5:14, *JB*).

It is just as God has said: "He will teach you all things." (John 14:26)

Works cited

Feynman, R. P., R. B. Leighton, and M. Sands. *The Feynman Lectures on Physics*. Menlo Park: Addison-Wesley, 1965. Vol. 3, p. 1-1 under "Atomic Mechanics"

The Holy Bible. Scriptures cited are from the *New American Standard Bible (NASB)* unless otherwise noted by the following abbreviations:

JB Alexander Jones, ed., The Jerusalem Bible. Garden City, New York; London: Doubleday; Darton, Longman & Todd, 1966.

NASB New American Standard Bible, Nashville: Holman Bible Publishers, 1977

NIV New International Version, Grand Rapids: Zondervan, 1984

NKJ Arthur Farstad, ed., Holy Bible: The New King James Version. Nashville: Thomas Nelson, Inc., 1982

Other Links (not in the original paper):

For a forum discussion about concepts similar to those in this paper

visit: <http://www.fqxi.org/community/forum/topic/294>

(forum essay itself is at http://www.fqxi.org/data/essay-contest-files/Fraser_NatureOfTime.pdf)

For my thoughts about the evolution/creation issue in the K-12 schools

visit: <http://telicthoughts.com/blind-faith/#comment-225829>

For more fascinating insights in quantum mechanics visit [Intuitive Concepts in Quantum Mechanics](#) .

For some insights on Special and General Relativity visit [In Search of the Geometry of Space, Time, and Motion](#)

<http://scripturalphysics.org/etc/ReflectiveEssay.html>

Motion couplers and momentum converters

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revised 2-5-2010n+

last modified 3-25-15

(Please see [previous section](#) about Motion Cancellers before reading this one)

Electromagnetic science is full of non-intuitive concepts—things that seem contrary to common sense and what you were taught in high school physics. Consider, for example, how two charged particles interact when one is moving and the other is not (or when they are on perpendicular trajectories):

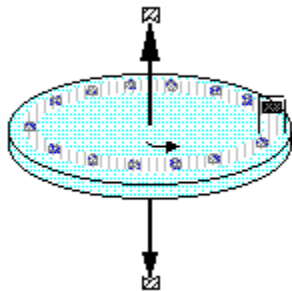
"We pointed out in Section 26-2 the failure of the law of action and reaction when two charged particles were moving on orthogonal trajectories. The forces on the two particles don't balance out, so the action and reaction are not equal; therefore the net momentum of the matter must be changing. It is not conserved. But the momentum in the field is also changing in such a situation. If you work out the amount of momentum given by the Poynting vector, it is not constant.. However, the change of the particle momenta is just made up by the field momentum, so the total momentum of particles plus field is conserved." (*The Feynman Lectures on Physics*, Vol. 2, p. 27-11)

Newton's law of action/reaction does not apply in certain situations in electromagnetics, because the "force" is actually canceled a motion instead of producing one. This allows other motions to become manifest. To get the total picture, you have to look at what happens not only to the particles, but to the rest of the situation, something we currently call the "electromagnetic field". And because we live on a gravitationally bound reference system that is actually moving multidimensionally at the speed of light, things get even weirder when particles move at high speeds. See *The Feynman Lectures on Physics*, Vol. 2, section 13-6 "The relativity of magnetic and electric fields" and chapter 26, "Lorentz Transformation of the Fields".

See also my comments about [reactionless force](#) , [railgun recoil](#) , and [reactionless propulsion](#).

In the [previous section](#) you saw how motion of the wire in space produces mechanical energy. I further proposed that *motion of space in the wire* also produces energy, but of a different sort, namely electrical energy with an attendant magnetic field. Let us suppose now that we replace linear motion with rotational motion for these cases. Do we still get a picture that is self-consistent? Can we still extract energy from either system? More particularly, can we extract momentum? Energy has only a magnitude, but momentum has both a magnitude and a direction. Seeing what is going on with momentum would be even more illuminating than seeing what is happening with the energy.

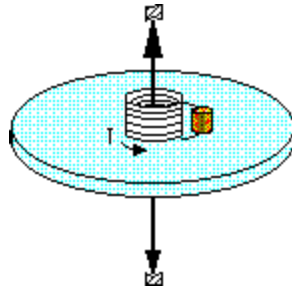
To illustrate the issues, consider the behavior of the device shown in the illustration below. The marbles are revolving at high speed in a frictionless tube which is anchored to a turntable. The turntable is initially stationary, but is able to rotate freely. The system clearly has angular momentum, but if the tube is opaque, this is not obvious to an external observer. The observer can command the gate valve to close however. When it suddenly closes, the marbles will stop "flowing" in the tube and collide with the gate valve, which is securely mounted on the turntable. This rotational equivalent of "water hammer" will cause the turntable to start rotating.



A disc has a tube full of marbles. The marbles inside the tube are rapidly revolving around the central axis of the disc inside a frictionless tube. The disc itself is stationary but is free to rotate.

If the gate valve suddenly stops the flow of marbles, will the disc start to rotate?

Now suppose we have a coil of wire (a solenoid) with current circulating through it instead of a tube with marbles. According to the "Motion Cancellers" discussion on the previous page, this system will likewise have angular momentum, but in this case, it is caused by space rotating in the wire, instead of the wire rotating in space. Suppose we command the battery to disconnect. The electric current must suddenly stop. The space revolving in the wire (electric current) comes to a halt. What then happens to the alleged angular momentum of the system? Does it just disappear? Or does it cause the turntable to rotate as in the previous (mechanical) example?



I can tell you from personal experience what will happen. You'll see a big, fat spark when the battery disconnects, but the turntable will not rotate.

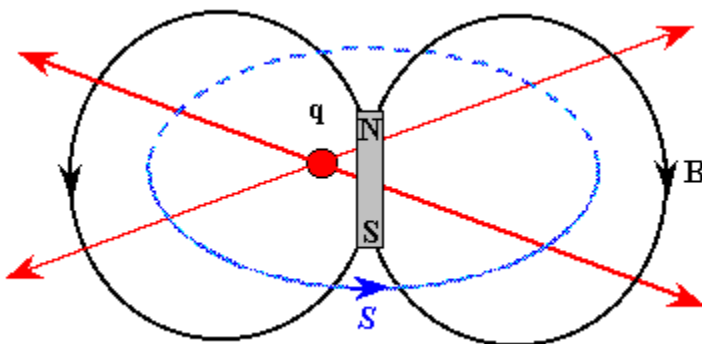
As a kid I used to play with inductors and batteries. I would connect a battery to a couple of wires from an old audio transformer, or a couple of wires from an old fluorescent light ballast. I noticed that some hookups would produce a little spark, some would produce a big, fat snappy spark, and others would produce nothing. When I got a couple of fingers across the terminals and disconnected the wire, I would sometimes get one heck of a shock. How could a little 6 volt battery and a little coil of wire produce such a high voltage?

Years later I would learn about $V = L(dI/dt)$. This says that the voltage across an inductor is proportional to the time rate of change of the electric current. Disconnecting the wire caused the current (I) to change very suddenly. The time derivative of this is numerically large, and this causes the high voltage and fat spark. The energy which is stored in the (now) collapsing magnetic field suddenly returns to the wire.

Electrical engineers will tell you that inductors act like an electrical flywheel and capacitors act like an electrical storage tank. Either can store considerable energy. When you disconnect a capacitor from a battery, you leave it with a "full tank of electric fluid" (so to speak). The energy remains stored, and does not have to go anywhere. But when you disconnect an inductor, the "flywheel" suddenly stops, and you get the electrical equivalent of water hammer. This is usually not desirable, and protective devices are inserted into circuits to dissipate the high voltage pulse. A diode, or a small lamp, for instance, will allow the current to circulate momentarily and come to a gradual stop even when the battery is disconnected suddenly.

So this little experiment demonstrates that an inductor stores *energy*, but does not specifically demonstrate storage of *angular momentum*. Mechanical momentum and electrical momentum still seem to be rather separate concepts. Yet according to the Motion Cancellers discussion (which you read previously) these should be equivalent. We should be able to show, without "cheating", that the *electrical* angular momentum can be turned into *mechanical* angular momentum by using fundamental electromagnetic principles directly, and without interposing some sort of energy conversion device.

This is NOT an intuitively easy problem to solve. However, the Poynting vector, and Feynman's comments about it, will serve to educate our intuition:



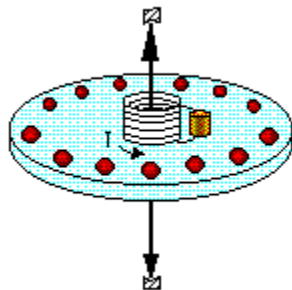
A stationary charge and a permanent magnet produce a Poynting vector (\mathbf{S}) that just circulates in closed loops.

There is a circulation of energy in this situation but any bounded volume has as much energy leaving it as entering it.

"Suppose we take the example of a point charge sitting near the center of a bar magnet, as shown in [the figure]. Everything is at rest, so the energy is not changing with time. Also, \mathbf{E} and \mathbf{B} are quite static. But the Poynting vector says that there is a flow of energy, because there is an $\mathbf{E} \times \mathbf{B}$ that is not zero. If you look at the energy flow, you find that it just circulates around and around. There isn't any change in the energy anywhere—everything which flows into one volume flows out again. It is like incompressible water flowing around. So there is a circulation of energy in this so-called static condition. . . .

You no doubt begin to get the impression that the Poynting theory at least partially violates your intuition as to where energy is located in an electromagnetic field. . . . The circulation of energy around a magnet and a charge seem, in most circumstances, to be quite unimportant. It is not a vital detail, but it is clear that our ordinary intuitions are quite wrong." (*The Feynman Lectures on Physics*, Vol. 2, p. 27-8)

With that in mind, consider a little gizmo Feynman describes. It is very similar to our problem, except that it includes some spheres that are charged with static electricity:



A plastic disc has charged metal spheres around its periphery. A small battery powers a solenoid (a coil of wire) on the disc. The disc is stationary but is free to rotate.

If the battery is disconnected and the current I stops, will the disc rotate?

"Do you remember the paradox we described in Section 17-4 about a solenoid and some charges mounted on a disc? It seemed that when the current turned off, the whole disc should start to turn. The puzzle was: Where did the angular momentum come from? The answer is that if you have a magnetic field and some charges, there will be some angular momentum in the field. It must have been put there when the field was built up. When the field is turned off, the angular momentum is given back. So the disc in the paradox *would* start rotating. This mystic circulating flow of energy, which at first seemed so ridiculous, is absolutely necessary. There is really a momentum flow. It is needed to maintain the conservation of angular momentum in the whole world." (p. 27-11)

Of course, this is not a good way to make an electric motor. Motors must operate continuously. The illustrations simply show that motion of mass through space, and motion of space through mass have analogous behavior.

The physics of electromagnetism has a lot of concepts that seem strange and awkward on first encounter. The physics of space/time ratios and the concepts of multidimensional motion will, hopefully, allow you to become more comfortable with these concepts.

See also:

"Observation of Static Electromagnetic Angular Momentum *in vacuo*," Graham and Lahoz, *Nature* V. 285, May 15, 1980, p.129; "Although this result is to be expected by classical electromagnetism, it leads inexorably to the acceptance of the physical reality of the Poynting vector, even though \mathbf{E} and \mathbf{H} arise from independent sources. . . . permanent magnets and electrets can be used to build a flywheel of electromagnetic energy steadily flowing in circles in the vacuum gap of a capacitor as if Maxwell's medium were endowed with a property corresponding to superfluidity." <http://www.tts.lt/~nara/introduc/introduc.htm>

"Engineering the Zero-Point Field and Polarizable Vacuum for Interstellar Flight ", H.E. Puthoff*, S.R. Little, and M. Ibson: "This raises the issue as to whether static (i.e., non-propagating) \mathbf{ExH} fields also constitute momentum (as the mathematics would imply), and in particular whether changes in static fields could result in the transfer of momentum to an attached structure. As it turns out, the answer can be yes as illustrated in the example of the Feynman disk paradox. . . Even though nothing is apparently in motion, if we take the \mathbf{ExH} momentum concept seriously, it would appear that there is angular momentum "circulating" about the disk in the static fields. . . ." http://www.stealthskater.com/Documents/Puthoff_1.pdf

Feynman Cylinder Paradox, John Belcher, Kirk T. McDonald (1983, 2002) http://www.physics.princeton.edu/~mcdonald/examples/feynman_cylinder.pdf

"Gyroscope's unexplained acceleration may be due to modified inertia", Lisa Zyga (July 26, 2011) by <http://phys.org/news/2011-07-gyroscope-unexplained-due-inertia.html>

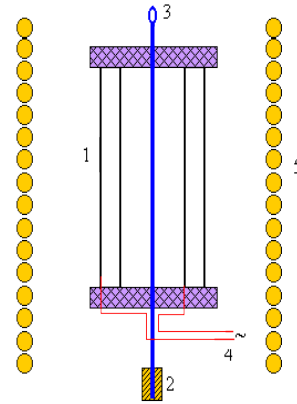
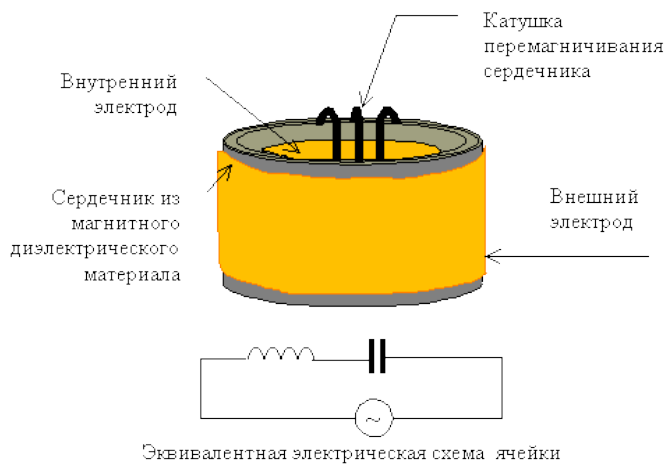


Fig. 1. 1 - cylindrical capacitor, 2 - torsion-oscillator system, 3 - mirror for optical lever, 4 - radial leads, 5 - superconducting solenoid

<http://www.tts.lt/~nara/amper/neutron.html>

<http://www.tts.lt/~nara/introduc/introduc.htm>

m (Grahm-Lahoz)

(more gizmos to think about)

"Asymmetry and Energy in Magnetic Systems", <http://www.steorn.com/images/asymmetry-and-energy-in-magnetic-systems.pdf>

"Magnetic Torque Measurement System" <http://www.steorn.com/images/magnetic-torque-measurement-system.pdf>

"The problem of creating something which is new, but which is consistent with everything which has been seen before, is one of extreme difficulty. "
(*The Feynman Lectures on Physics*, Vol. II, p. 20-10 to 20-11)

Space/time dimensions for some electromagnetic quantities

We saw previously that energy is t/s , that mass and inductance are both t^3/s^3 , and that electrical current is s/t . It is possible to use these dimensions to derive other dimensions for electrical quantities. Power (energy per time), for instance, is $1/s$.

The less obvious dimensions can be derived from common electrical formulas. The voltage across an inductor, discussed above, is $V = L(dI/dt)$ and we can use it to find the dimensions of voltage ("electric

potential"). Hence, $V [=] t^3/s^3 (s/t)(1/t) \text{ or } t/s^2$. We can also readily see that the formula is analogous to $F = ma$, where $a = dv/dt$. Voltage even has the same space/time dimensions as mechanical force.

Electric field intensity (E) is measured in volts per meter and therefore is t/s^3 . This can also be derived from formulas found in college level textbooks on electromagnetic science:

$$\begin{aligned} power &= I \int_C E \cdot dl \\ \left(\frac{1}{s}\right) [=] \left(\frac{s}{t}\right) E \left(\frac{s}{1}\right) \\ \left(\frac{t}{s^3}\right) [=] E \end{aligned}$$

In a similar way we can find the space/time dimensions for a magnetic field:

$$\begin{aligned} \oint_C E \cdot dl &= - \int_s \dot{B} \cdot ds \\ \left(\frac{t}{s^3}\right) \left(\frac{s}{1}\right) [=] B \left(\frac{1}{t}\right) \left(\frac{s^2}{1}\right) \\ \left(\frac{t^2}{s^4}\right) [=] B \end{aligned}$$

Does $E = cB$ agree with these dimensions? We can readily see that it does.

Does it work for the Hertzian wave equation?:

$$\begin{aligned} \nabla^2 \mathbf{B} - \frac{1}{c^2} \frac{d^2 \mathbf{B}}{dt^2} &= 0 \\ \nabla^2 \mathbf{E} - \frac{1}{c^2} \frac{d^2 \mathbf{E}}{dt^2} &= 0 \end{aligned}$$

Dimensions of terms that are added or subtracted must be the same. Hence, for the first equation (\mathbf{B}):

$$\frac{\frac{t^2}{s^4}}{\frac{s^2}{s^2}} = \frac{t^2}{s^2} \frac{\frac{t^2}{s^4}}{\frac{t^2}{s^2}}$$

which comes out to t^2/s^6 for both terms; and for the second one (**E**):

$$\frac{\frac{t}{s^3}}{\frac{s^2}{s^2}} = \frac{t}{s^2} \frac{\frac{t}{s^3}}{\frac{t}{s^2}}$$

which reduces to t/s^5 for both terms.

The magnetic vector potential (denoted as **A**) is also very important in electrodynamics. It has the dimensions of momentum per charge. That comes out as $(t^2/s^2) (1/s)$ or t^2/s^3 . The **B** field is supposed to be the curl (mathematically a spatial derivative) of the **A** field. That comes out as $(t^2/s^3)(1/s) = t^2/s^4$ and is as shown above.

Incidentally, the magnetic vector potential is another one of those historical oddities:

"This subject has an interesting history. The theory we have described was known from the beginning of quantum mechanics in 1926. The fact that the vector potential appears in the wave equation of quantum mechanics . . . was obvious from the day it was written. That it cannot be replaced by the magnetic field in any easy way was observed by one man after the other who tried to do so It seems strange in retrospect that no one thought of discussing this experiment until 1956, when Bohm and Aharonov first suggested it and made the whole question crystal clear. The implication was there all the time, but no one paid attention to it. Thus many people were rather shocked when the matter was brought up. . . . It is interesting that something like this can be around for thirty years but, because of certain prejudices of what is and is not significant, continues to be ignored." (*The Feynman Lectures on Physics*, Vol. 2, page 15-12)

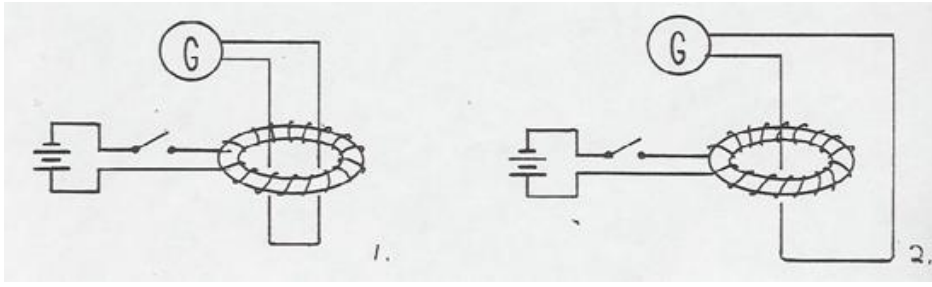
Because the vector potential **A** is regarded as more fundamental in quantum electrodynamics "**E** and **B** are slowly disappearing from the modern expression of physical laws; they are being replaced by **A** and ϕ ." (*ibid.*, page 15-14)

See also:

"Thoughts on the Magnetic Vector Potential", John R. Taylor, 1996. <http://www.scribd.com/doc/24546297/Thoughts-on-the-Magnetic-Vector-Potential-by-John-R-Taylor>
 "What the electromagnetic vector potential describes", E. J. Konopinski, 1977, http://physics.princeton.edu/~mcdonald/examples/EM/konopinski_ajp_46_499_78.pdf
 "Apparatus for Generating Motional Electric Field", William J. Hooper, 1972. <http://www.research.com/hooper/3610971.htm>
 "New Biophysical Field Attacks Cancer Cells", Ivan Rampl, 2008. <http://www.rampl.eu/>

Simple demonstration of vector potential reality:

"If a wire is threaded through the hole of the toroid and returned through the hole, case 1, no galvanometer deflection is seen as **B** is switched on and off. But if the wire is threaded through the hole and returned around the coil, case 2, a galvanometer deflection will be seen from $= -d\phi/dt$. "



See this link for

details: http://www.physics.ucla.edu/demoweb/demomanual/electricity_and_magnetism/electrodynamics/vect_or_potential.html

See also:

http://pages.videotron.com/ceber/on_the_einstein-de_haas_and_barnett_effects.pdf ; <http://encyclopedia2.thefreedictionary.com/Einstein-de+Haas+Effect>

"The Connection Between Inertial Forces and the Vector Potential", Alexandre A. Martins, Mario J. Pinheiro <http://arxiv.org/ftp/physics/papers/0611/0611167.pdf> ;

<http://www.freepatentsonline.com/EP0920141A2.pdf>

<http://www.freepatentsonline.com/4447779.pdf>

<http://www.freepatentsonline.com/EP0050523A2.pdf>

<http://www.freepatentsonline.com/4491795.pdf>

But there are some troubling inconsistencies in electromagnetic space/time dimensions. The Poynting vector is usually interpreted as power per area which comes out to $1/s^3$. The literature also expresses it as

$$S = gc^2$$

where g is the momentum density (momentum per volume) and which has the dimensions of t^2/s^5 . According to this formula then, S works out to be $1/s^3$, exactly as expected. But we are not so fortunate when expressing S in terms of E and B as in this formula:

$$S = \epsilon_0 c^2 E \times B$$

The permittivity, ϵ_0 , is expressed in coulombs per volt per meter. Charge is the one-dimensional analog of mass, and so permittivity is probably $(t/s)(1/(t/s^2))(1/s)$, which appears to be dimensionless. The dimensions for the remaining items have been given previously, and with those, S works out to be $(s^2/t^2)(t/s^3)(t^2/s^4)$ or t/s^5 . That is obviously NOT the same as $1/s^3$ which is what we were expecting. Did we mess up something when we used the vector cross product? Does S have some alternative interpretation which would account for the discrepancy? Has a term inadvertently been left out of the formula? Is a profound insight lurking here somewhere?

Perhaps the guess on the dimensions for permittivity were wrong. Simple inspection shows that they would have to be (s^2/t) for the Poynting formula to work out correctly. Permittivity is used in formulas for capacitance,

so maybe we can look at some capacitance formulas, explore the dimensions, and see if our new guess for the ϵ_0 dimensions is reasonable. Here is a good formula (*Electrical Engineering Circuits*, H.H. Skilling, 2nd ed., p. 18) to start with. It has obvious space/time dimensions and little else:

$$C = \epsilon_0 \frac{A}{s}$$

C is the capacitance, ϵ_0 is the permittivity of free space (vacuum), A is the area of the plates, and s is the separation between plates. Plugging everything in, we find that the dimensions for capacitance (C) are $(s^2/t)(s^2)(1/s)$ which is just (s^3/t) .

We now must find out if these dimensions for capacitance make sense. If they do, then the new choice for the permittivity dimensions is probably correct as well. Let's try the formula for current through a capacitor (note that v is voltage here, not velocity):

$$\begin{aligned} \text{current} &= C \frac{dv}{dt} \\ \left(\frac{s}{t}\right) [=] & C \left(\frac{t}{s^2}\right) \left(\frac{1}{t}\right) \\ \left(\frac{s^3}{t}\right) [=] & C \end{aligned}$$

This is perfect. We were hoping that the space time dimensions of capacitance would work out to be (s^3/t) and that is exactly what we got. We can now confidently check other capacitance formulas and see if they to give the same dimensions for capacitance. Here is one that relates the charge on the capacitor plates to capacitance and voltage:

$$\begin{aligned} \text{charge} &= CV \\ \left(\frac{t}{s}\right) [=] & C \left(\frac{t}{s^2}\right) \\ \left(\frac{s}{1}\right) [=] & C \end{aligned}$$

And we find . . . that it doesn't work. Instead of getting (s^3/t) , we get just (s) .

Let's go back to the original capacitor formula: $C = \epsilon_0 (A/s)$. If permittivity were dimensionless as originally supposed, the formula above, $\text{charge} = CV$, would be dimensionally correct. In other words, capacitance is just a space unit.(s). If we take that value and plug it into the formula for current, we find that current is (s/t) instead of (t/s) . This seems to be trying to tell us something.

Rather than have two kinds of capacitance, it is more reasonable to believe that there are two kinds of electric current. This has already been discussed [elsewhere](#). One type of electricity, the so-called "static electricity", is

based on coulombic charge which has the dimensions of (t/s). Ordinary electric current, however, is just space per time (s/t), like a velocity, as discussed above and in the first section. Maybe "storing current" in a capacitor is equivalent to stuffing it with space units. Or maybe is it equivalent to stuffing it with coulombic charge units. Which is it? The formula for force exerted on a charge by an electric field between the plates of a capacitor is $F = QE$. Force is (t/s²) and electric field is (t/s³). It is obvious that the kind of Q (charge) we are looking at here must have the dimensions of (s) and not (t/s). In contrast to the inductor, what the capacitor stores is a "stopped" version of (s/t) or, in other words, just (s). And unlike the inductor, the electricity does not "squirt back out" when the battery is disconnected; a capacitor acts more like a storage tank than a pressurized accumulator (especially when the dielectric is a vacuum).

The conceptual problems here can be illustrated by thinking about a capacitor storing electrons as though it were a jar that stores marbles. Note that the marbles are stored throughout the jar's volume, not just on the jar's surface, and that the jar has limited capacity. If we want to store more marbles, we need to have a jar with more space. However, the marbles (electrons) represent space units (rotational space). Putting space units into the jar, and then asserting that the jar is running out of space does not make any sense. We need a jar that has temporal volume instead of spatial volume. That way, adding more electrons creates a space/time (or time/space) ratio. This ratio also implies a limited capacity. But how do we put more temporal volume into a capacitor? As explained previously, matter itself is a temporal structure (t³/s³). Putting a slab of matter between the two plates, creates more temporal volume, more "capacity". Some materials work better than others for this purpose, and this in turn leads to concepts like "capacitivity"—something that is today called "permittivity".

Permittivity is thus an actual physical characteristic, and therefore should NOT be a dimensionless quantity. The second guess on the dimensions for permittivity (s²/t) is probably correct.

Anyway, the point here is that space/time dimensions for electromagnetic and mechanical quantities can be worked out, despite some obvious difficulties and long standing misconceptions. **Ultimately, everything in physics can be expressed in terms of space/time ratios of some sort. This can lead to new insights about the true nature of these entities and their relationships with other entities.**

For example: the electric field has the dimensions of t/s³ (as shown above; (t/s³ can also be energy density)). The second time derivative of that would be (t/s³)/t² which comes out to t³/s³ [?? (t/s³)/(1/t²) ?? math error ?*], which has the same dimensions as mass. That implies that a pulsed electric field could have a mass effect (a.k.a. "motional effect"). Could this be the real physics behind the [Podkletnov Impulse Gravity Generator](#)? See [3-30-11 Update](#) and [6-14-03 Update](#) This invites even further speculation. Could a magnetic "charge" ("flux", t²/s²) be somehow "physically" combined with an electric charge (t¹/s¹) to get a "mass field" (t³/s³) yielding a (temporary) motional effect? Does the Biefeld-Brown effect through the Poynting vector and the magnetic and electric components of Feynman's carrousel (above) represent physical implementations of these relationships? [*the math here is wrong and this explanation cannot be valid. The *second* time derivative, d² (t/s³)/dt², is akin to an acceleration of the electric field intensity. The *first* time derivative, d (t/s³)/dt, is equivalent to 1/s³ which could be power/area. Neither of these alternatives seems to suggest a gravitational effect. However, power/area is the same dimension as the Poynting vector, which apparently has something to do with "ether power flow" (for lack of better words) and hence, gravitation. A spatially accelerated B field also has these dimensions: B=t²/s⁴ as above, and a = s/t² and so (B)(a) = (t²/s⁴) (s/t²) which comes out to 1/s³ or power/area; however, this might require a homopolar configuration. What really seems to matter in all this is, not just power flow, but momentum density. Says Feynman:

"There is an important theorem in mechanics which is this: whenever there is a flow of energy in any circumstance at all (field energy or any other kind of energy), the energy flowing through a unit area per unit time, when multiplied by 1/c², is equal to the momentum per unit volume in the space. In the special case of electrodynamics, this theorem gives the result that **g** is 1/c² times the Poynting vector:

$$\mathbf{g} = 1/c^2 \mathbf{S}$$

So the Poynting vector gives not only energy flow but, if you divide by c^2 , also the momentum density."

In a charging cylindrical capacitor, or even a current in a resistance wire, the Poynting vector is directed radially inward, and therefore the momentum is likewise. The radial components balance out, and so in the case of the resistance wire, heat, not motion is the result. If the capacitor is asymmetrical the momentum components will not balance as in the radial case, and there will be "leftover" momentum pointing in some direction.

There are two things to consider here: First, the c^2 factor suggests enormous electric and magnetic fields will be required for "motional effects". But momentum is also related to radiation reaction, and that in turn, according to Feynman, is related to the third time derivative of position (something engineers and physicists call "jerk") of the electric charge used to produce the radiation. (Feynman, Vol 2, p. 28-7) The "back reaction" force on a radio antenna emitting 1 kW of radiation is equivalent to the weight of a few fleas. But these systems use sinusoidal acceleration fields and the "jerk" is relatively mild, and the charge motion is cyclic. In contrast, the fields in experiments giving levitation effects are described as very intense, unidirectional, and pulsed in such a way that the "jerk" on the charge has an extremely high value. (See [Piggott example](#) and [Podkletnov Impulse Gravity Generator](#) ; See also [Poynting Vector Reversal](#))

Second, reconsider the example above with the static electric field and permanent magnet. Remember that the sources of the E and B fields can be independent. Feynman points out that the energy (and momentum) is just going around in circles. But a circulating momentum is angular momentum. So this is kind of like a flywheel, but it is constructed from the "ether" so to speak. To extract energy from it, something has to change, and this leads us back to Feynman's disk paradox where the magnetic field is turned off, and the disk experiences a rotational impulse.

Electromagnetic theory is still incomplete. Maxwell's equations do not include the Lorentz force, nor anything about the relation of gravity to electromagnetism. Additionally, there are still some very messy, difficult issues. Says Feynman:

"In bringing together relativity and Maxwell's equations, we have finished our main work on the theory of electromagnetism. . . . this tremendous edifice, which is such a beautiful success in explaining so many phenomena, ultimately falls on its face. . . . Now we want to discuss a serious trouble—the failure of the classical electromagnetic theory. . . . the classical theory of electromagnetism is an unsatisfactory theory all by itself. . . . when electromagnetism is joined to quantum mechanics, the difficulties remain. " (*The Feynman Lectures on Physics*, Feynman, *et al.* (1964) Vol 2, p. 28-1)

There are indications that the early post WWII UFOs used rotating magnetic fields in their propulsion systems. One way to get spatially large magnetic effects would be to use intense, time-changing electric fields. One equation is $E = cB$. It implies, due to the c factor, that the electric field intensity would have to be enormous to generate even a miniscule magnetic effect. A time changing electric field induces a magnetic field, and so very fast time changes are also required. This suggests a machine that uses fields of hundreds of millions of volts and switching times on the order of nanoseconds. A van de Graaff generator with spark gap switching is probably the first thing that would come to mind; however, far more sophisticated machines of various designs can be built today. And, in line with the above thinking, a spatially accelerated magnetic field could be produced by rotating the electric field by means of multiple electrodes and multiple switches. This suggests a design somewhat like that seen on a "drone" in California:



<http://www.youtube.com/watch?feature=endscreen&v=BXpVJnpu8Ac&NR=1> ; For a discussion, see ADVPROP.html#StrangeFlyingMachi

Others have noted the relevance of rotating magnetic fields. Says physicist Eugene Podkletnov: (http://www.youtube.com/watch?feature=player_embedded&v=AgyAFEIQZcU) 2
1:00 --> “But to be absolutely honest now, after twelve or fifteen, already, years of research in this field, we came to the conclusion that it is not necessary to use superconducting materials in order to modify the gravity field. We can use rotating magnetic fields, and we can turn to normal conductors, which is much easier, much easier, and uh, ah, this method has a lot of advantages.” http://portal.groupkos.com/index.php?title=Eugene_Podkletnov_portal

See also [my views on UFOs](#) in Make Sure of All Things

Books:

The Feynman Lectures on Physics, Vol. 2, Feynman, Leighton and Sands, 1964 <http://www.scribd.com/doc/20698010/Vol-2-Ch-27-Field-Energy-and-Momentum>

Basic Properties of Matter, Dewey B. Larson, 1988

New Light on Space and Time, Dewey B. Larson, 1965

Nothing But Motion, Dewey B. Larson, 1979

Links:

The Reciprocal System, <http://www.rsystem.org>

The Collected works of Dewey B. Larson, <http://www.rsystem.org/dbl/index.htm>

An update on the "electron as space" concept (6-14-2004)

The various discussions in the first article above have been based on the premise that an electron acts like a unit of actual space. The presentation so far has included the following concepts:

1. Space moving through a wire partially cancels one dimension of gravitational motion and leaves a magnetic field as a residual effect.
2. Space moving through a wire has energy effects that are exactly analogous to the wire moving through space.
3. Space rotating in a coil of wire has angular momentum effects analogous to a coil of wire rotating in space

We can now mention evidence for another concept:

4. Enormous electric current in a wire adds physical space between the atoms of the wire and may even cause the wire to tear apart. If the ends of the wire are securely clamped, the wire may buckle back upon itself.

Adding more space to a wire reduces its material density. In other words we would expect the wire to expand. If this could be done with extreme suddenness, the ordinary forces that keep the atoms of the wire together will be overcome, and the wire will be blown apart. However, the effect would be mechanical, rather than thermal; the wire does not melt or vaporize.

Evidence for just such an effect comes from experiments of Dr. Peter Graneau, Dr. Jan Nasilowski and others. They found that in electrodynamic wire explosions, the breaks were due to tensile stress (which act longitudinally) rather than pinch-off forces (which act radially). The wire seems to pull itself apart into discrete fragments in these experiments.

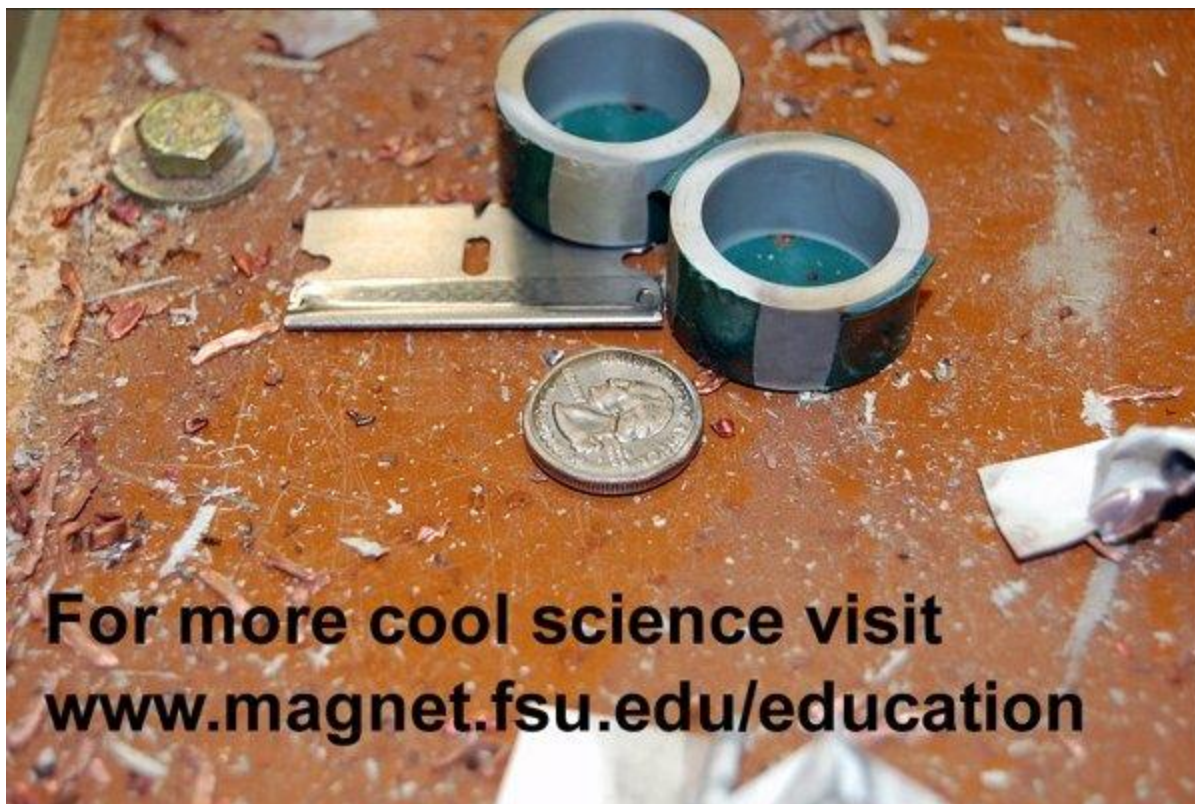
A similar experiment was done with segments of a copper rod stacked vertically in a glass tube. When an enormous current pulse was sent through this stack, the copper segments moved apart. Photos showed multiple electric arcs between the segments.

Explanations for railgun recoil effects have led to similar conclusions. In these experiments the rails are securely anchored and have no freedom to expand. Sometimes the rails crumple back upon themselves as though there were tremendous unrelieved expansion forces. It is an effect similar to an asphalt road "washerboarding" on a hot summer day.

In conclusion:

"We have thus seen how solid conductors can bend and buckle, and even shatter, if subjected to high current pulses. The discussion indicates that some kind of longitudinal stress is present." , <http://www.df.lth.se/~snorkelf/Longitudinal/node3.html> , <http://www.df.lth.se/~snorkelf/Longitudinal/node5.html> <http://www.df.lth.se/~snorkelf/LongitudinalMSc.pdf>

You can see an example of this at <http://www.magnet.fsu.edu/education/tutorials/slideshows/shrinkingquarter/index.html> . A pulsed magnetic field is used to compress a U.S. coin to about 75% of its original diameter. Note the shards of copper wire after the experiment. The wire was blown apart, *not melted*, by 100,000 amps!



(I am waiting for the day when someone uses powerful electric and magnetic fields to cause a coin to "de-localize". The coin will disappear entirely from the experimental setup.)

"A Bibliography of the Electrically Exploded Conductor Phenomenon," by William G. Chace and Eleanor M. Watson, published by the Armed Services Technical Information Agency. http://www.dtic.mil/cgi-bin/GetTRDoc?AD=AD0299253&ei=-awUrSVOJDyoASBhoD4Aw&usg=AFQjCNEFD9cm912JxlQITL8tr1BosLH1Sw&sig2=ZMsqHYjVGvTU_XrTBEH8Iw&bvm=bv.58187178.d.cGU&cad=rja

If more space can be added to a material aggregate and result in a decrease in density, then it is natural to also ask: "Can more time be added to a material aggregate and result in an increase in density?" If this can be done, then the possibility of producing materials with ultrahigh densities and attendant useful properties might become a reality. Ultrahigh density diamond, for example, should be able to easily cut through normal diamond.

The possibility of making "high energy density materials" is of great interest to the military. Chemical explosives have specific energies of 5 MJ/kg. Thin film batteries and superconducting rings have about 1 to 50 MJ/kg. In chemical explosives the energy comes from chemical bonding, which is about 10eV per molecule. Superdense materials would have bond energies MUCH higher than this.

Conventional high explosives, for example, have specific energies on the order of 5kJ/g and maximum mass densities of 2 g/cm³. This corresponds to an energy density of 10 kJ/cm³. So-called "metallic hydrogen" is believed to have an energy density of about 270 kJ/cm³ which would be about 35 times more energetic than TNT. It could be used as a powerful "conventional" (non-nuclear) military explosive. A bomb containing one ton of metallic hydrogen would then be equivalent in destructive potential to 35 tons of ordinary TNT. It could also be used to make nuclear weapons much more compact, possibly even obviating the use of a fission trigger (fission makes the bomb radioactively dirty, and the materials required for the fission trigger are very expensive

and hard to obtain; a design with no fission trigger would make cost proportional to explosive power, but could also prove to be a proliferation nightmare). As a rocket fuel, metallic hydrogen would have high specific impulse, say, 1400 sec compared to 400 sec for JP4 + liquid oxygen. As an aircraft fuel it would have 300 times more energy than the best available, which implies a flight range 300 times normal. Astronomers are well aware of the existence of extremely high density matter, such as that in white dwarf stars. They also know about high density structures, such as compact, high velocity jets, and even compact galaxies. There is no generally accepted comprehensive theory explaining the "compactness" features of the universe. With tongue in cheek I can say that it might just be a matter of time.

For more information see:

Fourth Generation Nuclear Weapons, Andre Gsponer, Jean-Pierre Hurni, 1999, 6th ed., p. 101 to 121;

[Google "patent 905847 German Karl Nowak"](#) to find information on experiments done in Nazi Germany on extreme densification of materials (jet fuel, explosives, etc.). The method used high pressure compression and cryogenic cooling.

Science News, Vol. 157, Jan 22, 2000, p. 54 (octanitrocubane);

"Nitrogen Power: New crystal packs a lot of punch", Science News, July 17, 2004, Vol. 166, p.36-37, www.sciencenews.org/articles/20040717/fob4.asp)

"The Nuclear Threat That Doesn't Exist – or Does It?" by Sam Cohen and Joe Douglass, March 11, 2003 <http://www.financialsense.com/editorials/douglass/2003/0311.htm> (comments on ballotechnics and red mercury)

[Ray guns, Nuclear Isomers, Rydberg Atoms](#)

<http://www.aip.org/pnu/2004/690.html> "Why Do Transformers Hum?", Physics News Update, Number 690, June 30, 2004

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http://scripturalphysics.org/4v4a/motion_couplers.html

What is Scriptural Physics?

Scriptural Physics is a method of acquiring fundamental knowledge about the physical universe that is guided by principles found in the Bible. Physics itself is the study of the interaction between matter and energy. More generally, it is a search for the fundamental rules that govern the physical universe.

Scriptural Physics has the following characteristics:

- Scriptural Physics seeks to find a fundamental underlying physical reality that is usually invisible and not experienced directly. In this sense it has much in common with the biblical conception of faith which depends on "evidence of things not seen." And like faith, the reality often turns out to be something unexpected, something contrary to outward appearances.
- The methodology of Scriptural Physics is largely inductive instead of deductive. That is, it proceeds inferentially from particular to general. It begins with specific facts and then tries to infer powerful principles that would encompass these facts and perhaps predict the existence of other phenomena yet undiscovered. In this regard, Scriptural Physics is rather ordinary, and not unlike the so-called scientific method, or even just plain old common sense.
- Scriptural Physics uses ordinary principles of biblical interpretation. Whatever the Bible meant to people of ancient times, it is taken to have basically the same meaning for us today. Likewise, what it did *not* mean to them, it does *not* mean to us today. This is required by the fact that the Bible was written in a historical manner anchored to real people and common, human circumstances. It was clearly not about physics, and because a scripture cannot mean today what it never meant in the first place, there is no point in looking for "secret messages that were concealed by the Holy Spirit in ancient times for the modern physicist" (or gamblers, fortune-tellers, etc., etc.)
- Scriptural Physics does not use "miraculous revelation" from God. The Scriptural Physicist acquires knowledge the old fashioned way: he *works* for it!

Biblical principles central to Scriptural Physics include the following:

Principle #1: The Physical Universe is worthy of study.

"He seals the hand of every man, that all men may know His work . . . Stand and consider the wonders of God. Do you know how God establishes them?" (Job 37:7, 14-15)

"The heavens are telling of the glory of God; and their expanse is declaring the work of His hands. Day to day pours forth speech, and night to night reveals knowledge. There is no speech, nor are there words; Their voice is not heard. . . . How many are your works, O Lord! In wisdom you made them all." (Psalm 19:1-3, *NASB*, 104:24, *NIV*)

"Great are the works of the Lord; They are studied by all who delight in them" (Psalm 111:2)

Principle #2: The Physical Universe is intrinsically reasonable, understandable, and accessible to man.

"What may be known about God is plain to them, because *God has made it plain* to them. For since the creation of the world God's invisible qualities—his eternal power and divine nature—have been clearly seen, being understood from what has been made, so that men are without excuse" (Romans 1:19-20, *NIV*)

"Do you know the ordinances of the heavens? . . . Where is the way that the light is divided? . . . Where is the way to the dwelling of light?" (Job 38:33, 24, 19; Note that these are "physical" questions, and that they are also "fair" questions that must have answers that are understandable by mankind.)

"All Scripture is given by inspiration of God, and is profitable for doctrine, for reproof, for correction, for instruction in righteousness, that the man of God may be complete, thoroughly equipped for every good work." (2Timothy 3:16-17)

"The anointing you received from [God] abides in you, and you have no need for anyone to teach you; but . . . His anointing teaches you about all things, and is true and is not a lie" (1John 2:27; John 14:26))

"walk as children of light for the fruit of the light consists in all goodness and righteousness and truth" (Ephesians 5:8-9)

"His divine power has granted to us everything pertaining to life and godliness" (2 Peter 1:3)

"Those who seek the Lord understand all things" (Proverbs 28:5; See also Proverbs 1:7, 29-33, 9:10, Psalm 111:10)

"The Lord will give you understanding in everything." (2Timothy 2:7)

"He has made everything beautiful in its time. Also He has put eternity in their hearts, except that no one can find out the work that God does from beginning to end." (Ecclesiastes 3:11, *NKJ*)

"I applied my heart to know, to search and seek out wisdom and the reason of things . . ."
(Ecclesiastes 7:25)

Principle #3: The Bible outlines principles that pertain to perception of the invisible.

"Faith is the substance of things hoped for, the evidence of things not seen. . . . By faith we understand that the worlds were framed by the word of God, so that the things which are seen were not made of things which are visible." (Hebrews 11:1-3, *NKJ*; Hebrews 11 goes on to give examples such as that of Moses who "endured as seeing Him who is invisible.")

See "[Perceiving the Invisible](#)" in *Make Sure of All Things*

Principle #4: The Bible outlines principles that pertain to obtaining reliable knowledge.

"The naive believes everything. But the prudent man considers his steps" (Proverbs 14:15)

"Test the spirits to see whether they are from God (1 John 4:1-3)

"Examine yourselves . . . Test yourselves" (2Cor 13:5)

"Do not be carried away by varied and strange teachings" (Hebrews 13:9)

For a fuller exposition, see "[Examine Everything Carefully . . .](#) " in *Make Sure of All Things*

Scriptural Physics is an intersection of physics and biblical principles. To many people, it will seem like an odd combination—like the combination of a can-opener with a mouse trap. How could you use such a contraption? It is also unfamiliar and suffers from a lack of context that allows you to "fill in the blanks." Suppose you knew nothing about "brushing your teeth" but someone briefly explained it to you. The explanation made sense, but what do you do with the toothpaste in your mouth? Swallow it? It tastes good, after all. Or spit it out? Or if you have never seen an onion and someone tells you "An onion is food," then should you eat one like an apple?

Scriptural Physics suffers from the same sort of problems. For example, in my view, the atom is really what we are currently calling the nucleus. That is, the atom does not *have* a nucleus. Rather, the atom *is* the nucleus. But this raises all sorts of other questions, and I cannot even hope to discuss them. And what about Quantum Mechanics? Isn't there quite a large body of evidence supporting its validity? But if you are a Christian and you accept it, then how do you handle topics like action-at-a-distance, matter waves, tunneling, the uncertainty principle, and a host of other very strange, bizarre concepts?

To address this problem, I have included another article at this website, [Make Sure of All Things](#). It is about my personal experiences in dealing with blind spots, illusions, "strange teachings" and deceptions in orthodox Christianity. It illustrates principles of interpretation, rules of evidence, obviation of controversies, and methods of perceiving the invisible. It also gives insights on how Christians may handle hyper-difficult and hyper-complex problems. Although it is a long article, my email indicates it has been highly readable, both by Christians and non-Christians alike. I hope you enjoy it too!

Some additional thoughts: I have wondered over the years why there are so many doctrinal differences and viewpoints among (serious) Christians. Aren't we all studying essentially the same Bible? Aren't we guided by the same Spirit? Shouldn't we end up discovering the same truths? Serious Christians do in fact agree on major *Biblical* teachings like faith, hope, love, righteousness, and the Ransom. But beyond that there are a lot of differences. In some major churches where the focus is on "church politics" and the "flow of authority and obedience", these are a really big, serious, *serious* issues. But other churches view them with a kind of disdainful tolerance. Still others don't even care; as long as a person accepts the Ransom and practices righteousness, he will be regarded as truly Christian. Why doesn't God step in and set us all straight?

I think there are two basic reasons. First, He intends to let our behaviors over these problems become manifest. And second, (and most important) He intends to make us *think*. Most of us were educated in the public school systems. There, we were taught to look for the "correct answer". In chemistry class, we have to get the correct answer. In math class we had to get the correct answer. The habit of seeking the "correct answer" became subtly ingrained in our thinking patterns. But what happens when the "correct answer" is not known? Or in dispute? You either end up *really thinking*, or you end up just following the crowd and accepting the authority of the currently popular "reigning paradigm". The former is a lot of hard work. And it leaves you wondering if you really are doing the right thing, or if your thinking really *is* off in the weeds. While our

institutions require conformity to what has been officially decided to be "truth", Christians have a more cautious, nuanced view of these matters. We are looking for spiritual truths that the world does not, and cannot know. God is working within us to help us be comfortable with this trip through *terra incognita*. Rest assured you will get even more practice with Scriptural Physics!

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"Physics *is* like a religion. It is founded on the belief that there is reason in nature which the human mind is capable of fathoming. The articles of faith are that the natural world is fundamentally interesting, that the effort to understand it is worthy of pursuit, and that the pursuit will be made despite all obstacles. It is a demanding religion, but initiation is open to all."
(*Waves and Grains: reflections on light and learning*, Mark P. Silverman, 1998, p. 405)

"To live in the presence of great truths and eternal laws—that is what keeps a man patient when the world ignores him and calm and unspoiled when the world praises him." (*Honore Balzac*)

"The fear of the LORD is the beginning of knowledge" (Prov. 1:7)

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<http://scripturalphysics.org/4v4a/whatissp.html>

Project Whitefire

preliminary edition

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updated 12-4-16

Overview

Project Whitefire had its origins in the document [ElectromagneticTestCells.html](#). The intent was to build hardware to investigate the gravitational effects of positive monopolar pulsed high voltage power, including interactions with high voltage RF fields, and microwaves as described in that document. A second phase was intended to investigate the gravitational effects of rotating pulsed fields. But the project proved impossible to schedule and was cancelled. Most of the parts and subsystems for the van de Graaff generator were made however, and I am now trying to upload drawings and photos that may be helpful to others who intend to build this machine and do the suggested experiments. The drawings were made in Microsoft Word (the buggy, cluttered 2013 version-from-hell); they are informal, do not follow any strict conventions, but should be sufficient for machining parts. They were converted to .pdf with the free on-line service at <http://freepdfconvert.com> or by simply saving them as .pdf directly from MS Word. Drawings have *not* been double checked for errors and may have some ambiguities or inconsistencies. (Feedback is appreciated: brianfraser427@yahoo.com)

Initial "shakedown" tests on this VDG (see photos below) showed :

- the machine can produce robust (loud!) sparks about 3.2 inches long with a repetition rate of 1.2 times per second when connected to a (leaky) cylindrical PVC capacitor
- the short circuit current easily exceeds the 50 microamp range on an old (mechanical) RadioShack meter and is probably around 70-100 microamps.
- when one of the belt drives was disconnected, the short circuit current was about 40 microamps. Some minor sparking and corona were apparent (somewhere). Full output probably exceeds 80 microamps.
- the short circuit current test showed that the upper terminal has positive polarity (as expected)
- the prototype belt charge spray unit of 25 kV produced no measurable effect on spark repetition rate or short circuit current. (The prototype unit consists of a battery, an ignition coil, and automotive breakerpoints/capacitor driven by an electric drill with a 4-lobed cam in the chuck. The unit itself works very well.)
- further improvements to the triboelectric charging scheme (Teflon roller sleeves, different belt material, etc) could increase the output to ~~300 to 800~~ microamps
- One lower roller was covered with Teflon tape (specifically, "PTFE thread tape 3/4 x 300 heavy duty", Enco part No. 073-06900476) and the other roller/belt system was disconnected. When the VDG was turned on, the short circuit current was initially 15 microamps and rose to over 50 microamps after 7 minutes. The increase in current due to the Teflon coating was nowhere near the expected value.
- The same roller was later stripped and re-coated with Teflon tape for gas piping (4 mil, 3/4" width, yellow, less porous [Zoro source](#)). The roller was retested and gave a current of 65 microamps.
- Testing short circuit current with a 50 microamp meter is very useful for seeing the effects of belt tension, belt cleanliness, brush spacing, charging schemes, etc. A mechanical meter with a 100 microamp range would be a better match to this machine's output.
- Short circuit testing with a EDM-80 mechanical microammeter (-10 to +100; http://www.amazon.com/Eisco-Analog-Ammeter-Current-Meter/dp/B00IUZ9GOS/ref=sr_1_1) gave max indicated current of 90 microamps; (both rollers using ordinary Teflon thread tape; **Weather:** ambient 64.4F, Dew point 41F, Relative Humidity 42% . During these short circuit tests, the lower, unenclosed part of the column bistles with static electricity. It was later wrapped with clear plastic food wrap. Output rose to 110 microamps (on a 500 microamp meter) . There is apparently a lot of leakage from corona and this is limiting the current and voltage

output (even with the top terminal shorted to ground through the meter). This design may be "too compact" for using ambient air as an insulator.

These drawings and photos in the links below may be used nonexclusively by anyone for educational, personal, or non-commercial use. User assumes all liabilities and responsibilities for his use and acknowledges that these machines are not toys and can be very dangerous and have both known and unknown hazards in their intended use. Author retains right to maintain and update documents, photos, and website.

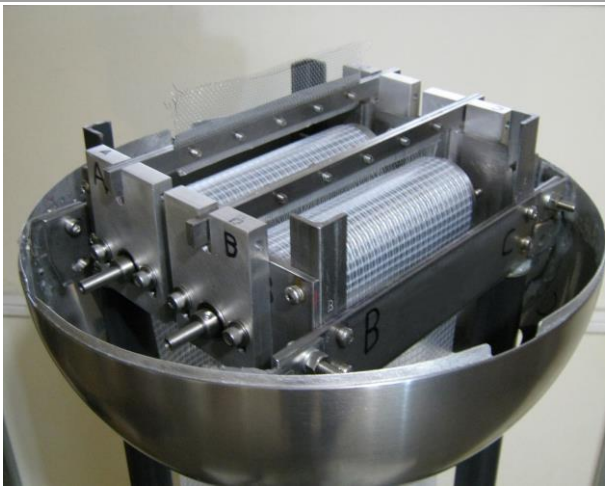
A summary of the research objectives can be found in [Non-contactLevitation.pdf](#) .

Van de Graaff Generator (500,000 volts)



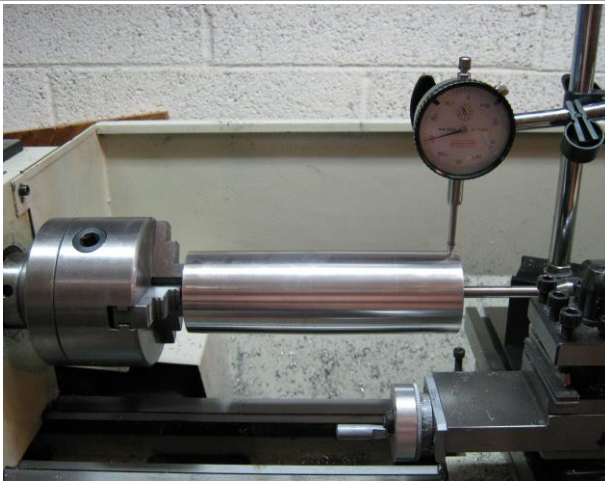
[Base+ColumnAssembly/Base+ColumnAssembly.html](#) (photos)

[Base+Column.pdf](#) (drawings)



[UpperTerminalSection/UpperTerminalConstruction.html](#) (photos)

[UpperTerminalFramework.pdf](#) (drawings)



[MakingTheBeltRollers.html](#) (photos)

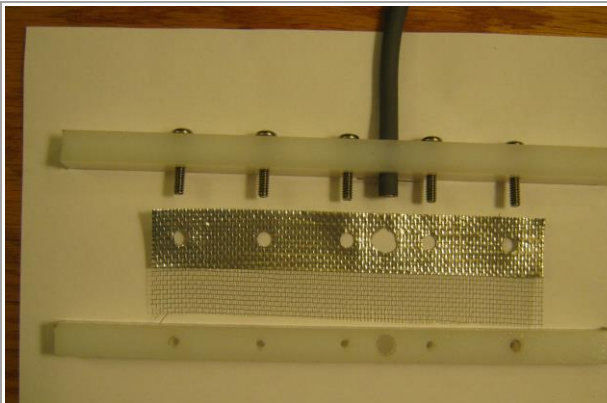
[RollerDrawings.pdf](#) (drawings)



[Belts/BeltMaking.html](#)



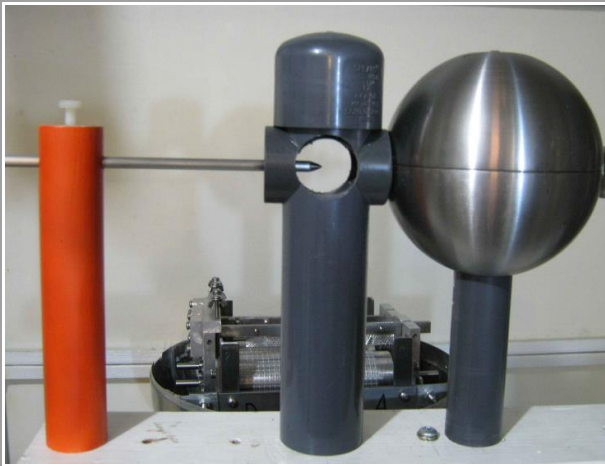
[LowerBearing&BrushHolder.html](#) (photos)
[Bearing+Brush_Supports.pdf](#) (drawings, lower and upper)



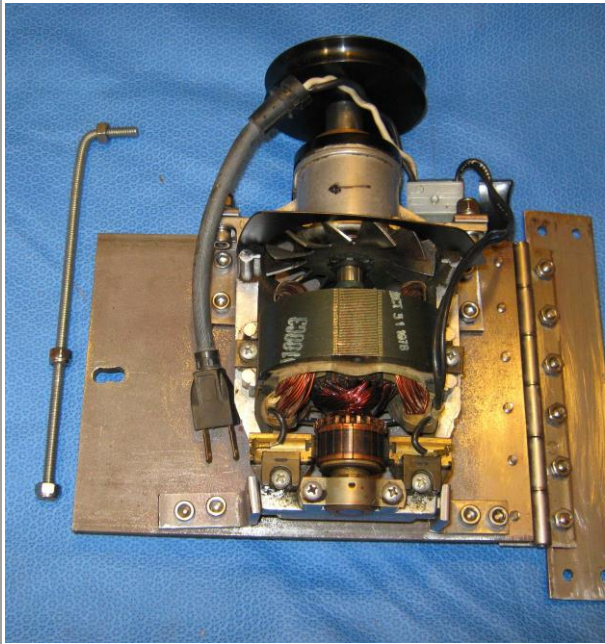
[Brushes.html](#) (photos)



[Provisional Brush Power Supply](#) (photos)



[SparkSystem.html](#) (photos)
[SparkSystem.pdf](#) (drawings)



[MotorAssembly.html](#) (photos)
[Custom_motor_shroud.pdf](#) (drawing)
[Gear_safety_shield.pdf](#) (drawing)

Accessory Equipment post

Controls

[BrokenTapDisintegration.pdf](#)

See pictures below of the assembled van de Graaff





Photo of the complete prototype Van de Graaff generator (VDG) in front of a garage door. Visible are the 14" upper terminal, one of two 6" wide belts, a simple control panel, and an electric drill driving automotive breaker points for a prototype 25kV lower brush supply.

The crease in the vinyl belt is due to a "double cone" profile of only 0.5 degrees on the upper roller. The bottom roller has a flat profile. Belt tracking and adjustment were satisfactory.



Here the double roller system and the two belts can be seen. The bottom rollers are PVC. The gears are barely visible in the back. The lower pulley is driven by an AC/DC "universal" chain saw motor. Violent starts are softened with two NTC thermistors (8 amp; Honeywell ICL2210008-01) connected in series with the power line. The accessory equipment post stands upright on the right. At the base, is the housing for the ignition coil.

This setup is very noisy during operation due to the AC/DC chain saw motor and the gears. An alternative would be to use an AC induction motor with a 2:1 or 3:1 (?) step-up pulley ratio. The gears could be replaced by a figure 8 belt and two pulleys of equal size



[MotorAssembly.html](#) (photos)
[Custom_motor_shroud.pdf](#) (drawing)
[Gear_safety_shield.pdf](#) (drawing)
[MotorAssembly.html](#) (photos)
[Custom_motor_shroud.pdf](#) (drawing)
[Gear_safety_shield.pdf](#) (drawing)

Another side view shows the gearbox cover.

This machine has no bottom terminal. It is not intended to produce sparks. The voltage and current produced are sent elsewhere to a test cell where the relation between gravity and high voltage, pulsed, monopolar, rotating fields can be systematically investigated.

See: [ElectromagneticTestCells.html](#)

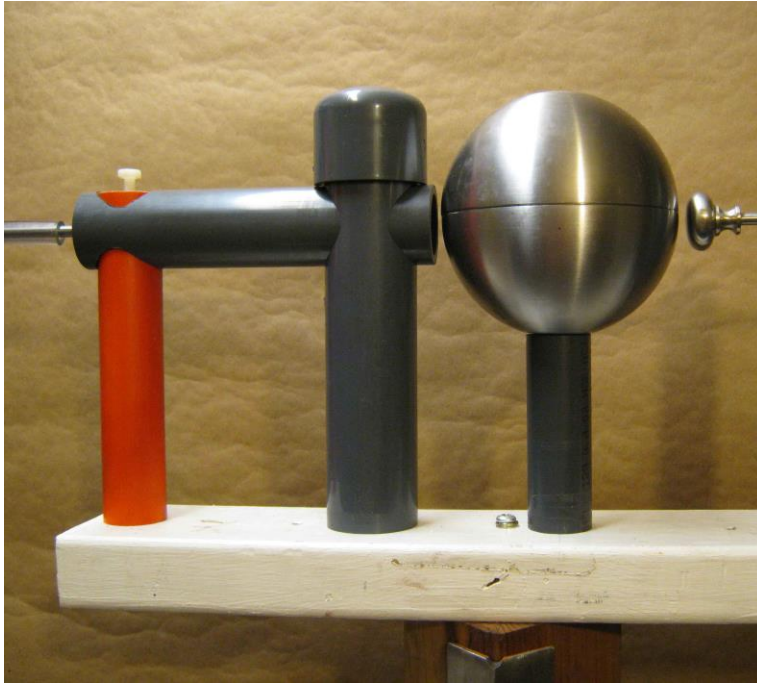
In actual operation the column is wrapped in layers



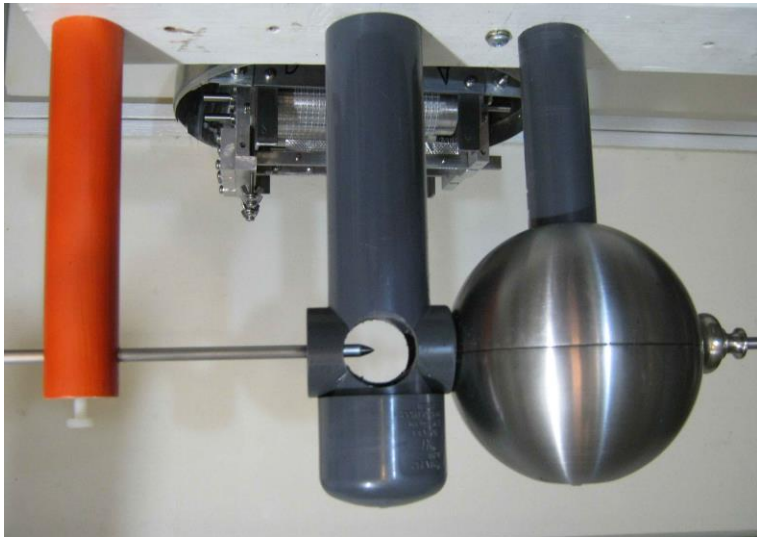
Corona control rings were later added to the van de Graaff

of plastic food wrap film, and the terminal is covered with a clear plastic trash bag, all to reduce corona. The lower brushes are presently connected to the power line safety ground, instead of the 25kV supply.

The main use of the equipment post is to hold the magnetic spark gap system:



original spark gap system



revised spark gap system

See SparkSystem.html for details.